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**A study of the wholist-analytic and verbal-imagery dimensions of cognitive style**

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**A study of the wholist-analytic and verbal-imagery dimensions of  
cognitive style**

**Meng Zhang**

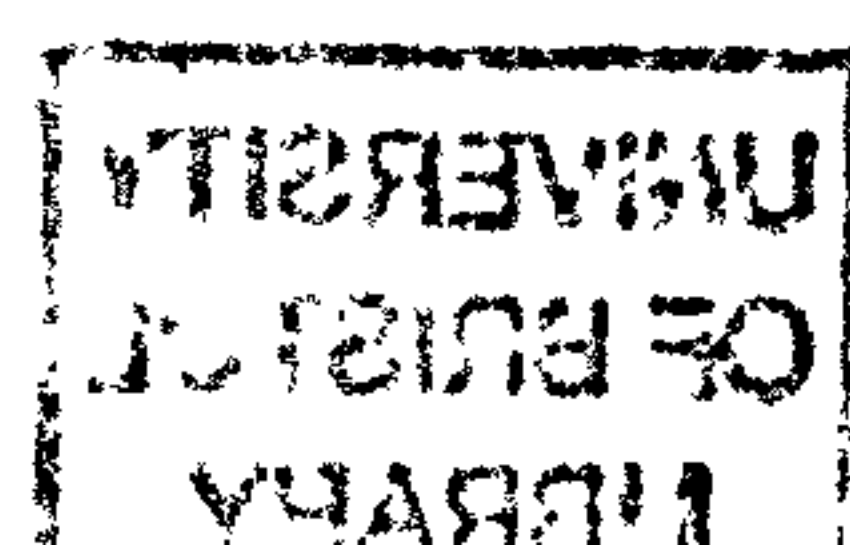
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## ABSTRACT

Individuals' consistent aptitudes in processing information are referred to as cognitive styles (i.e. the wholist-analytic and verbal-imagery cognitive styles). They have been suggested to be relevant to many observed behaviours especially in the learning and teaching circumstances. However, experimental evidence is required to support their validity and further the understanding of their nature.

The first stream of inquiry profiled different facets of the nature of the wholist-analytic cognitive style by various strands of evidence (see Chapter 2 to 5). The wholist-analytic cognitive style reflects the way in which an individual tends to organise information, either holistically or in parts. The findings revealed that the wholist-analytic cognitive style, as a valid and reliable construct, has impact on diverse cognitive processes, such as disembedding function, perceiving related/unrelated materials, integrating bodily information into a holistic self perception, and etc. All these observed effects were discussed to be consistent with the present understanding of this dimension of cognitive style.

The other stream of investigation examined the verbal-imagery cognitive style, which is concerned with information representation, verbally or pictorially. Although some evidence was found (see Chapter 2 and 5) to support to this cognitive style, the low empirical reliability of the measure (i.e. the verbal-imagery test of Cognitive Style Analysis test) reduced the certainty of the conclusion. By utilising an improved measurement, Chapter 6 investigated the construct validity of the verbal-imagery cognitive style with both behavioural and self-report measures. The results failed to support the current operational definition of this cognitive style. Critical discussions of this definition have been provided and more evaluations of it were suggested.

In addition, the "adaptation" between the two independent styles has been discussed

in conjunction with Curry's (1983) Onion Model of individual characteristics. A distinction between style and skill in the future research is required.



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**AUTHOR’S DECLARATION**

I declare that the work in this dissertation was carried out in accordance with the Regulations of the University of Bristol. The work is original, except where indicated by special reference in the text, and no part of the dissertation has been submitted for any other academic award. Any views expressed in the dissertation are those of the author.

SIGNED: *M. Zhang* 张萌.....

DATE: *10/12/2008*.....

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## **CHAPTER 1. INTRODUCTION OF THE WHOLIST-ANALYTIC AND VERBAL-IMAGERY DIMENSION OF COGNITIVE STYLE**

Traditionally, experimental psychologists have considered the variation caused by individual differences as 'noise' in psychological studies, and view it as barrier to generalising findings which must be minimised as much as possible (Plomin & Kosslyn, 2001). However, Kosslyn et al. (2002, p. 341) argued that 'the bridges between psychology and biology would be easier to forge if researchers treat each participant as an individual' therefore taking into account individual differences. The importance of investigating the role of individual differences on cognitive processes has gained prominence in the literature. Some researchers (e.g. Lamiell, 1981; Underwood, 1975) have claimed that naturally occurring individual differences may be more meaningful than conventional group methods of testing behaviours. Kosslyn et al. even asserted that data that does not take individual variation into account may be uninformative or misleading. Since then, a number of effects of individual differences on cognitive processes have been studied. For instance, some possible reasons for variation in cognitive performance have been concluded to relate to demographics, as well as personality and mental states, and physiology (e.g. neurochemistry etc). An individual characteristic, which is often linked to information processing, is cognitive style. This thesis aims to clarify further the nature of cognitive style and consider its effects on the cognitive performances in relation to behaviours.

In this introducing chapter, the author will review the development of the two cognitive style dimensions (namely, the wholist-analytic dimension and the verbal-imagery dimension), which are categorised by Riding and Cheema (1991), followed by critical evaluations of the theory and its concomitant measurement. An outline of contents

in the following chapters will close the chapter.

### **1.1 Riding's Two Dimensional Cognitive Style Model**

Cognitive style, which is a popular topic in the study of individual differences, contains a set of theories and constructs that seek to explain the way in which individuals view the world. It has been defined as “an individual’s characteristic and consistent approach to organising and processing information” (Tennant, 1988, p. 80), which has been viewed as a relatively fixed disposition that leads to differences in behaviour (Shipman & Shipman, 1985). The concept of cognitive style has been mentioned as a factor to consider in studying a wide range of observed behaviours, such as learning and social behaviours (e.g. Ramakrishna & Schilhavy, 1986; Riding & Rayner, 1998; Slocum, 1978).

Although there is a widespread belief that cognitive style is a constant and robust individual characteristic that is linked to a number of human behaviours and performances, it is not easy to define conceptually or operationally. Since the 1940s, many researchers have generated a large number of cognitive style labels from various points of view (e.g. Allard & Carlson, 1963; Bieri, 1966; Cohen, 1967; Holzman, 1966; 1971; Klein & Schlesinger, 1951; Kogan & Morgan, 1969; Messick & Kogan, 1963; Pettigrew, 1958; Santostefano & Paley, 1964). For example, cognitive style has been regarded as a subset of personality (e.g. Jung, 1970), learning style (e.g. Kolb, Rubin, & McIntyre, 1971), or even decision-making style (e.g. Rowe & Boulgarides, 1992). However, these different cognitive style models seem to be fairly isolated, which queries whether there is a common construct of cognitive styles. In addition, the operational definitions of these cognitive style labels arose from different researchers, varied periods of study, and diverse research questions. This has led to inconsistency and confusion in understanding the nature of

cognitive style. As a result, either the dimensions of cognitive style or the overlap between different labels of cognitive style is not clear enough, and it could be concluded that they need further establishment (e.g. Bostic & Tallent-Runnels, 1991).

In order to solve this problem, several researchers have worked on the categorisation of cognitive styles (e.g. Curry, 1983; 1987; 1991; Riding & Cheema, 1991; Rayner & Riding, 1997). Among them, Riding and his colleagues (e.g. Riding & Cheema, 1991; Riding, 1997; Riding & Rayner, 1998) have made impressive progress. They surveyed approximately 30 different cognitive style models and concluded that most of them can be categorised into two distinct style groups: namely, the wholist-analytic (WA) dimension and the verbal-imagery (VI) dimension.

These two basic dimensions of cognitive style can be summarised as follows (Riding & Rayner, 1998, p. 44):

(1) The wholist-analytic dimension reflects the way in which an individual would organise information, either globally or in parts.

(2) The verbal-imagery dimension reflects the way in which an individual would represent knowledge, either in words or in mental pictures.

This thesis aims to investigate these two dimensions of cognitive style with experimental studies in order to increase the understanding and reduce confusion in the research on cognitive styles. First, there is a brief review of the development of the two cognitive style dimensions.

#### *1.1.1 Development of the Wholist-Analytic (WA) Dimension of Cognitive Style*

Witkin and colleagues found individuals' perception of direction was affected by two experiences: 1) the surrounding area, as determined visually, and 2) the feeling of gravity, as reported by the physical senses (Asch & Witkin, 1948a; 1948b; Witkin & Asch, 1948a, 1948b). A consistent tendency was reported in that participants use only one type



of cue (e.g. either visual or postural) in their space orientation studies. This became known as the field dependence-independence (FDI) cognitive style. That is, the degree to which individuals rely on the external information from environment or internal feedback from their body to perceive direction. Witkin (1976) later concluded that the FDI cognitive style concerned the dependence upon the surrounding 'field' to a less or greater extent, when dealing with a task. So people who tended to use visual cues (from external information) were labelled 'field-dependents' (FDs) while those who preferred 'postural' cues (i.e. vestibular, tactile, and kinaesthetic, from an internal body sense) were labelled 'field independents' (FIs).

The theory about FDI cognitive style was developed and defined as the ability of individuals to segregate an object or information from its background/context (Witkin, 1976). He also referred to it as the extent to which people are analytical. Individuals showing high field independence (FI), who are at one extreme, are good at breaking down the information they perceive into component parts and focusing attention on the relevant parts only. They are not distracted by context and prefer problem-solving approaches that emphasise details and basic relationships. They were suggested to be analytical in nature, that is, are capable of perceiving information independent from the field/context. Field dependent (FD) persons, on the other hand, feel it necessary to employ the field/context/background when they perceive and have considerable difficulty in perceiving parts of a field as separate from the whole. They prefer more global, perhaps intuitive, approaches to problem solving.

This perceptual-analytical dimension, as named by Witkin (1965), was further developed by Riding and Cheema (1991) to become the wholist-analytic (WA) dimension of cognitive style with modifying the original uni-polar dimension of cognitive style (FDI) into a bi-polar one. An argued limitation of the FDI cognitive style is that it is only defined

(operationally) by a FI favoured task but ignoring any FD advantages (e.g. Riding, 2005). As a result, FDs always appear 'inferior' to FIs (i.e. reflecting a uni-polar dimension of cognitive style). In contrast, the WA cognitive style investigates both wholist and analytic tasks and consequently assesses both the wholist and the analytics ends of the dimension continuum (i.e. is bi-polar).

The new WA dimension of cognitive style refers to an individual's typical method for organising information, either as a whole or in parts. Wholists, who are equivalent to FDs, tend to see the whole of a situation and are able to hold an overall perspective by appreciating the total context. Analytics, on the other hand consistent with FIs, tend to see a situation as a collection of parts and focus on only one or two parts of the whole at a time, whilst excluding the others.

Besides the FDI style, Riding and Rayner (1998) also suggested a number of other cognitive style models that are theoretically featuring, or at least, relating to the WA cognitive style dimension. They include the levelling-sharpening dimension by Holzman and Klein (1954), the impulsivity-reflectivity dimension by Kagan, Rosman, Day, Albert, and Philips (1964), the convergent-divergent thinking dimension by Guilford (1967), the holistic-serialist thinking dimension by Pask and Scott (1972), the random-sequential dimension by Gregorc (1982), the assimilator-explorer dimension by Kaufmann (1989), the adaptor-innovator dimension by Kirton (1994), and the intuitive-analytic dimension by Allinson and Hayes (1996). However, it is fairly clear that the WA cognitive style dimension is mainly derived from the idea of FDI style (Riding, 2005), not only theoretically but also operationally.

Although there are debates about whether the FDI style shares attributes with intelligence or cognitive ability (e.g. Flexer & Roberge, 1980; Goldstein & Blackman, 1978; Kogan, 1983; Messick, 1976; Riding & Pearson, 1994), there is evidence that the

new WA cognitive style is independent of intelligence (see Riding, 1997). Further, the WA cognitive style is viewed as separate from, but interacting with personality, as well as relating to observed behaviours such as learning performance/preference and social behaviours (see Riding, 1997). Thus, the WA cognitive style is claimed to be a more 'pure' style compared to the original FDI cognitive style. In addition, Witkin and Goodenough (1981) and Riding (1997) agreed that cognitive style is relatively stable and will change little during the years of a person's life. However, Witkin (1965) implied that in very early childhood, there would be a tendency towards greater FI.

### *1.1.2 Development of the Verbal-Imagery (VI) Dimension of Cognitive Style*

Discrete from the WA dimension, which principally relates to cognitive organisation, the verbal-imagery (VI) dimension emphasises another crucial aspect of cognitive style, that is, the principal mode of mentally representing information (i.e. verbal or imagery).

Before discussing this dimension of cognitive style, a brief history of understanding of the nature of representations needs to be included. A concern of the imagery representation of knowledge can be traced back over a century (e.g. Bartlett, 1932; Galton, 1883). However, the existence of the imagery representation has been doubted as there have been many debates about the nature of the mental pictures; are they inner pictures or simply inner descriptions? This debate has led to the two main streams of research: the *Common Coding Theories* and the *Dual Coding Theories*. In general, the Common Coding Theories emphasise the dominance of language and commit to explaining the cognition process in terms of only one type of representation (i.e. verbal coding). The Dual Coding Theories, in which the most well-know work has been done by Paivio (1971a; 1986), propose two independent (nevertheless interconnected) verbal and non-verbal (imagery) representation and processing systems existing in human's cognitive function. The verbal



system specialises for dealing directly with language and the non-verbal (imagery) system specialises for dealing with non-linguistic events.

The Dual Coding Theory (Paivio, 1971a) has provided fundamental basis for the VI dimension of cognitive style as to suggest clearly the distinction between the two ways of thinking and knowing verbally or using imagery. This postulation has been greatly supported by the *Selective Interference Effect* (e.g. Atwood, 1971; Baddeley & Lieberman, 1980; Brooks, 1967; 1968; De Beni & Moe, 2003; Eddy & Glass, 1981; Hampson & Duffy, 1984; Janssen, 1976; Logie, Zucco, & Baddeley, 1990). When a person attempts to do two cognitive tasks simultaneously, his/her performance will be significantly more impaired if the two tasks involve the same representational coding (e.g. two verbal tasks, or two spatial tasks) than if the two tasks require different representational coding (e.g. a verbal task with a spatial task). The natural interpretation for this finding is that tasks involving different kind of representations interfere less with each other because they call upon different representational and processing resources.

In 1976, Riding and Taylor reported their finding that children's learning performance was affected by the way knowledge was presented. Consistent with Paivio's dual coding hypothesis, the difference was found between the word presentation and the imagery presentation. Riding (e.g. 1997) concluded that the VI dimension implies how information can be represented, either verbally or in mental pictures, and people constantly choose one although most individuals are capable of using either mode of representation. Verbalisers prefer, and perform best on verbal tasks, while imagers feel most comfortable representing information and performing tasks in mental pictures. When the environment demands and cognitive style are mismatched, for example, asking a verbaliser to complete an image task, performance was found to decrease (Riding & Caine, 1993).

Although there are several self-reporting preference questionnaires that were

created for measuring imagery 'abilities' (e.g. Paivio, 1971b; Richardson, 1977), none of them have been widely used and supported by enough evidence (see review by Riding & Rayner, 1998). Researchers have remarked the difficulties of measurement in this dimension as lack of internal control, failing to show correlations with objective performance on tasks (Ernest, 1977; Richardson, 1994; Riding & Cheema, 1991). In order to improve the situation, Riding and his colleagues (Riding & Taylor, 1976; Riding & Calvey, 1981; Riding & Cheema, 1991) have measured the VI cognitive style by comparing individuals' response times to either verbal or imagery required tasks. More details about this new objective approach will be discussed in later contents.

Riding (2005) also categorised a related family with the VI cognitive style (whereas much smaller than the WA style family). They are the abstract-concrete dimension (Harvey, Hunt, & Schroder, 1961) and the verbaliser-visualiser dimension (Paivio, 1971b). Although the VI cognitive style bears significantly less literature 'backup' compared to the WA cognitive style, it has been reported a great success in education practice, including learning and teaching in terms of attainment and attitudes/behaviours (e.g. Pearson, 2007; Riding & Rayner, 1998). It thus was claimed a valid dimension of cognitive style (see Riding, 2005).

### *1.1.3 The 'Third' Dimension of Cognitive Style Research*

Besides the above two dimensions of cognitive style, Riding (1991; Riding & Rayner, 1998) has also identified a 'third' dimension in the literature of style studies, which is argued to lie outside the spectrum of 'cognition-centred' individual differences. Grigorenko and Sternberg (1995) surveyed 'theories of style' and identified a departure from the literature of cognitive style, that is, an 'activity-centred approach'. Although the constructs related to this third dimension have been interchangeably labelled either 'cognitive styles' or 'learning styles' (Riding, 1996; Sadler-Smith, 1996), it is

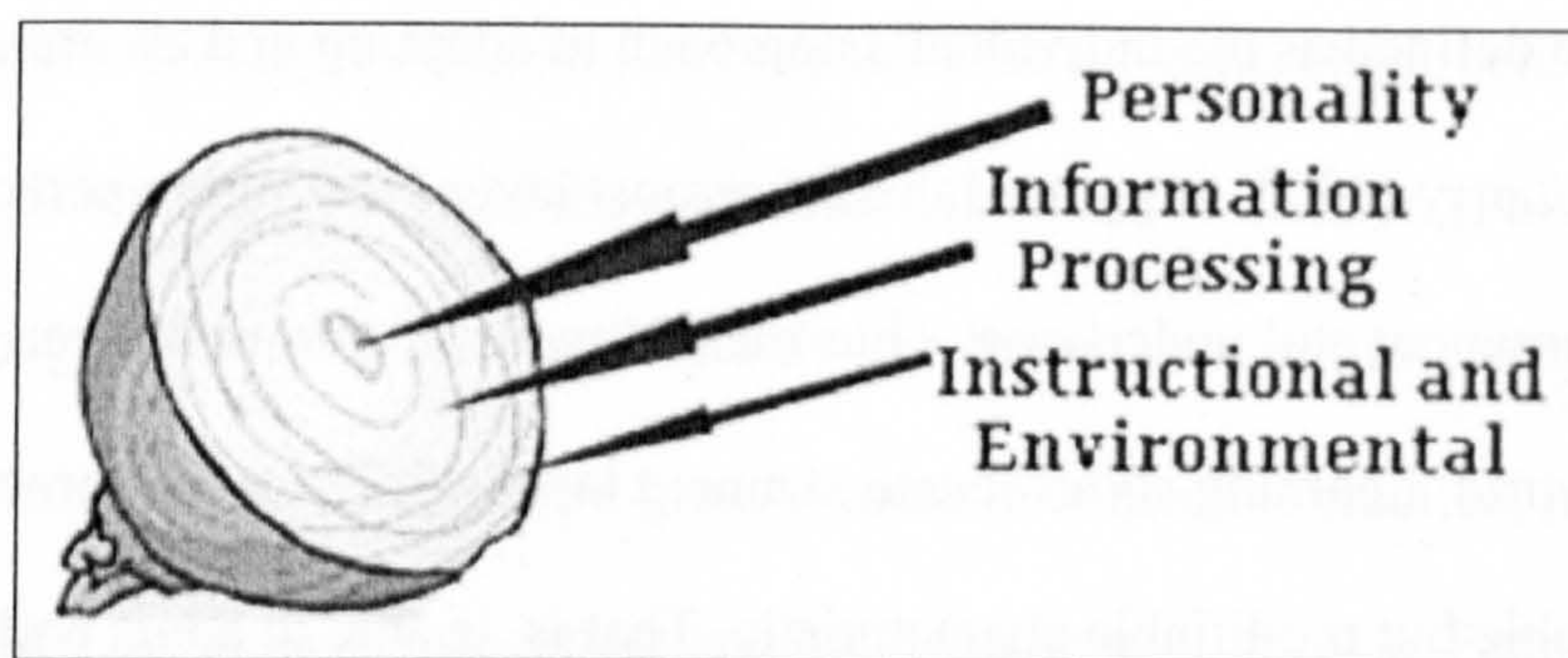
fundamentally distinct from the other two dimensions of cognitive style (Sadler-Smith, 1996). To clarify the understanding of this 'third' dimension in the cognitive style literature, it will be named 'learning style' throughout the thesis (i.e. it implies its 'learning activity-centred' nature). The distinction between the 'learning styles' and 'cognitive styles' can be well described by Curry's (1983) Onion Model.

It is believed that cognitive styles are more fundamental to an individual's personal and psychological makeup compared to learning styles. Curry (1983) conceptualised the separations of several style differences through the use of her Onion Model in which the layers of an onion are analogous to the different levels of a person's characteristic or style. Riding's (1997) categorisations of cognitive style dimensions locate at the core of the onion and are defined as the individual's approach to adapting and assimilating information. Curry (1983) suggested this innermost layer ("cognitive personality style") is relatively permanent and underlying. Thus these dimensions do not directly interact with the outside world. Learning styles locate at a next layer ("information processing style"), which is a stable but modifiable characteristic. That is, is able to adapt and develop through the experience to learning activities. The outermost layers are individuals' "instructional preferences" for learning. These refer to an individual's choice of environment in which to learn, which is most observable and far more likely to change during the interaction with others and the environment. The graphic illustration of the original Onion Model can be seen in Figure 1.1. Besides the initial three layers, Curry (1987) later included "social interaction" as a fourth layer of the onion. Social interaction provides the layer between the "instructional preference" and "information processing" and relates to the individuals' preference for social interaction during learning.

Subsequently Curry (1991) complemented her theory by the Theoretical Model of Learning Components and Effects to interpret learning styles or successes. In the new



model, she emphasised the maintenance of positive motivation and level of task engagement as components of learning styles as well as those habitual information-processing approaches. An individual's motivation level in a particular learning task is probably affected by the environmental and social situations (i.e. preferred or un-preferred), which will then lead to a corresponding degree of task engagement. And information processing only takes place once the individual becomes engaged in the task. By combining the three components, Curry is able to extend the concept of learning style as a concept that "...implies intention and willingness to stay focused on a particular learning task in a particular situation" (Curry, 1991, p. 252).



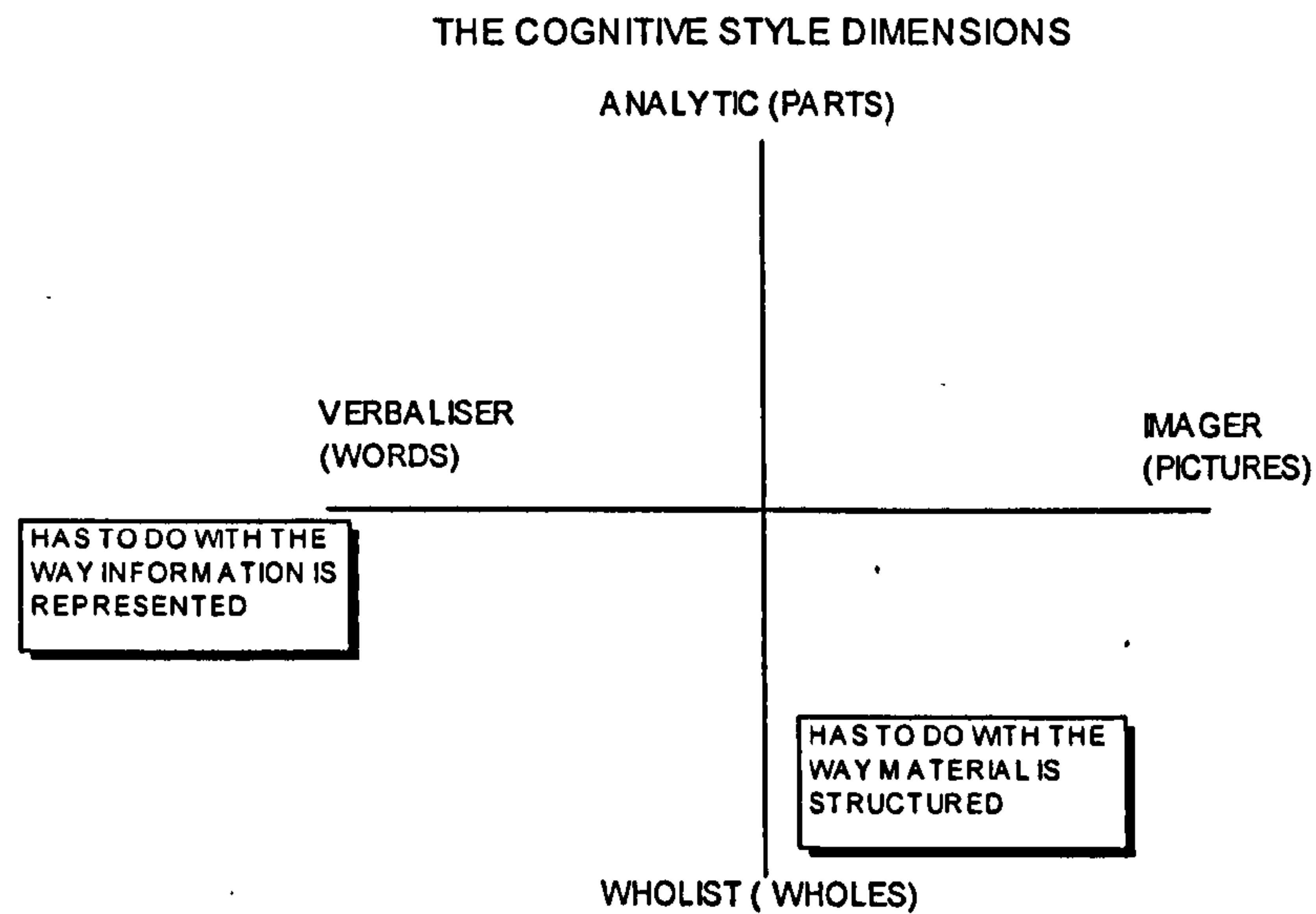
*Figure 1.1.* Curry's Onion Model (from Polhemus, Swan, Danchak, & Assis, 2005)

In sum, the research on learning style dimensions is more concerned with addressing the environment where the learning activities take place and has more emphasis on the pedagogical practice of dealing with individual differences (Grigerenko & Sternberg, 1995). The 'activity-centred' learning style is a distinct stream from the tradition of cognitive style research in psychology, which emphatically relies on cognitive functioning (a cognition-centred tradition). For this thesis, the consideration will be merely restricted to the first two dimensions (WA and VI) of cognitive style.

## 1.2 Critical Issues Relating to the Dual Dimensional Cognitive Style



### 1.2.1 The Relationship between the WA and the VI Dimension of Cognitive Style



*Figure 1.2.* The diagrammatical structure of the WA and the VI dimension of cognitive style (from Riding, 2005)

The WA and VI dimensions of cognitive style were claimed to be independent of each other, in that an individual's position on one dimension of cognitive style will not affect his/her position on the other dimension (Riding, 1997). Correlations between the WA and VI dimension have been reported as consistently low (around  $\pm 0.1$ ) (e.g. Riding & Agrell, 1997; Riding & Caine, 1993; Riding & Douglas, 1993; Riding & Pearson, 1994; Riding & Read, 1996). Diagrammatically, the model has been presented as a two dimensional illustration showing the bi-polar nature of the construct as Figure 1.2.

In addition, although the two cognitive style dimensions were assumed to be distinct as underlying mechanisms, they are also suggested to show "adaptation" between each other (Riding & Rayner, 1998). The verbal representations are typically viewed as componential (built upon phonemes/graphemes, words, sentences, etc.), which can be broken down to details. In contrast, imagery representations provide referentially



isomorphic and continuous knowledge, and keep the information of the target holistically. Consequently, a highly verbal person can be good at details as he/she is capable of extracting the discrete information from his/her linguistic representations of the object/event. Highly imagery people are able to hold an overall impression from the pictorial representation of the target/environment. Therefore it is possible to trigger one style dimension (e.g. VI dimension) when the feature of the other dimension (e.g. WA dimension) is not available. Riding and Rayner (1998) have provided an example for this case. An analytic-imager does not have the facility from WA dimension of cognitive style to obtain an overview of situations; however, his/her imagery representation of the environment can probably gain him/her the whole view by generating an image of the whole environment. Similarly, a wholist-verbaliser can have the analytic facility by employing the componential nature of verbal representations. Riding and Rayner (1998) named this substitutable effect 'adaptation'.

The statement of the adaptation between the WA and the VI style dimensions sounds plausible. If it is true, then the two dimensions of cognitive style must somehow relate to one another at a behavioural level. But the reported independence between the two dimensions makes it ill-supported. Do these two statements conflict? Or is this simply because the adaptation process is not reflected on the measurements? This is the paradox that Riding and Rayner (1998) failed to explain, and which will be discussed more fully in the next chapter.

### *1.2.2 The Invariability of Cognitive Styles*

Cognitive styles are well accepted as being an unchangeable individual characteristic (e.g. Curry, 1983; Riding, 1997). Riding also explicitly suggested that cognitive style is relatively fixed throughout the duration of one's life (Riding & Rayner, 1998). That is, cognitive styles, as preferred and habitual processes of an individual, are

incapable of modification. It seems that cognitive styles are 'default' positions on style continua that are stable and constant rather than variable. However, few longitudinal studies have been conducted to support this postulation.

Riding (1997) reported non-significant correlations between age and styles in samples from wide age ranges to support the invariability of styles. However, a few recent findings may imply a trend which is contrary to the above age-style-relationship. Atkinson (2005) found that as people grew older, they tended to be less extreme in both the WA and the VI dimensions of cognitive style compared to younger people. It is possible that the older people may have modified their cognitive styles over the course of life as non-extreme styles are more compatible with the changes of surrounding environments.

More evidence came from the WA family members (i.e. those cognitive style labels have been identified into WA style family by Riding and Rayner (1998)). Zhang, Allison, and Hayes (2005) investigated whether cognitive style would change when students moved from one culture (People's Republic of China) to a new culture (United Kingdom). They found a significant change occurred on the intuitive-analysis cognitive style dimension over a 6 month period. This result is corresponding to Bagley's finding (1988). Thirty-four Jamaican children who migrated to Canada were traced. It was found that after two years migration these children's FDI scores became higher (towards FI) and closer to their Canadian peers. In contrast, the control group of the non-migrant Jamaican children remained relatively FD (i.e. incurred lower scores). They suggested this is because life experience *may* affect cognitive style and when individuals are facing important changes in their lives, they would modify their style to improve the person-environment fit. These two studies were actually consistent with Atkinson's (2005) finding.

It could be argued that these studies did not directly challenge the invariability of cognitive style. As already mentioned, only a study of the dual dimensions (i.e. WA and

VI) with a longitudinal design may provide decisive evidence to address the question.

However, the studies do suggest that researchers need to re-think the extent to which individuals are able to move along the cognitive style continua in accordance with environment changes.

In conclusion, the two assumptions of cognitive style – the independence between the dimensions and the invariability – are suggested to be accepted with consideration. Although the previous findings displayed low correlations between the WA and VI dimension of cognitive style, Riding himself (Riding & Rayner, 1998) proclaimed an ‘adaptation’ process, which might relate the two style dimensions at the behavioural level. In addition, the extent to which cognitive styles are unchangeable is of interest. Those issues are worthy of further research.

### **1.3 Measurement of the Two Dimensions of Cognitive Style**

#### ***1.3.1 Cognitive Style Analysis (CSA)***

In 1991, Riding devised the computerised measurement - Cognitive Styles Analysis (CSA) - to assess the two dimensions of cognitive style (the WA and VI dimension; see Riding & Cheema, 1991). The aim of the work was to overcome the shortcomings of existed assessments of cognitive styles (e.g. GEFT and imagery-preference-related questionnaires) as well as to integrate the theory of cognitive styles into a single construct. Riding and Cheema (1991) has alleged that the uni-polar nature is the fundamental weakness of most measures of style, which could be responsible for overlap found between the style assessment and the ability-inability progression (e.g. FDI cognitive style is an evident example). Hence, CSA assesses both ends of style dimension (bi-polar) in order to reflect the style rather than the capability to complete a task (from bad to good). In addition, by employing an objective reaction time related assessment, CSA is able to avoid

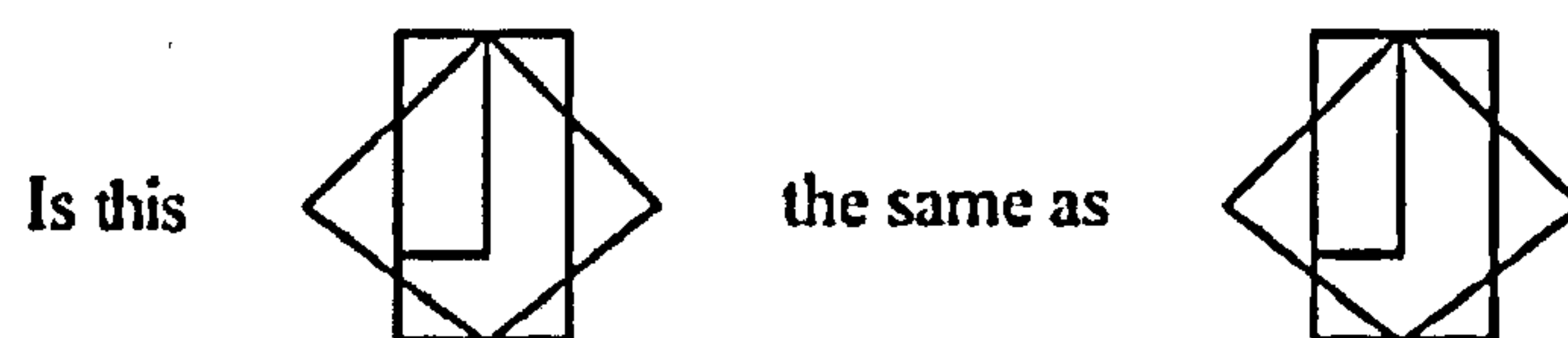


the major design limitations carried by the traditional introspective self-report measures. Notwithstanding, the instrument has been claimed to mirror previous findings in the area in which cognitive styles have been linked to a variety of learning tasks (e.g. Riding & Ashmore, 1980; Riding & Buckle, 1990; Riding, Buckle, Thompson, & Hagger, 1989; Riding & Calvey, 1981; Riding & Dyer, 1980; Riding & Taylor, 1976).

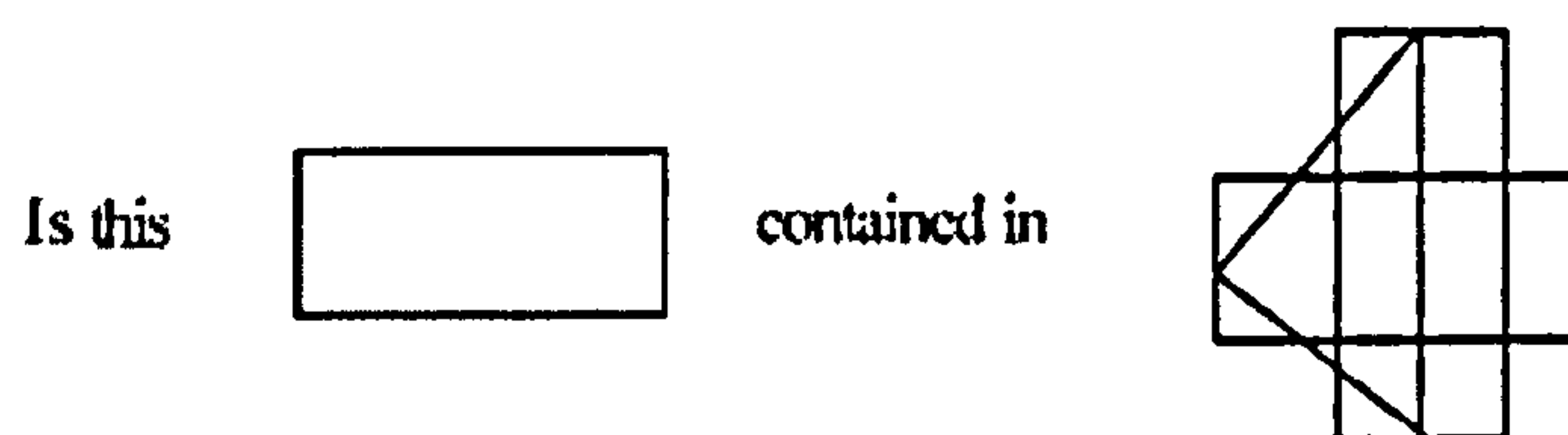
CSA comprises three subtests. The first subtest assesses the verbal-imagery (VI) dimension. The test was developed based on two previous VI tests: the Verbal-Imagery Code Test (VICT; Riding & Calvey, 1981; Riding & Taylor, 1976) and the Verbal-Imagery Learning Style Test (VILST; Riding et al., 1989), which determines children's position on the VI continuum of cognitive style by their responses to verbal and imagery questions. The task was developed into VI test of CSA. In CSA, participants are presented statements ( $n = 48$ ) that need to be judged right or wrong. Twenty-four of them contain information about conceptual categories (e.g. 'Are A and B the same type?'), and the rest contains information about the appearance of items (e.g. 'Are A and B the same colour?'). Half the items require the "same" response and half require the "different" response. The assumption is that the judgments of conceptual categories will evoke semantic/verbal representations while the judgments of item appearances will evoke the imagery representations. Although all statements will be presented in words, some neuropsychological studies have found that words can evoke the imagery representations for example naming colors actually activate the same brain area as perceiving colors (see Paivio, 2007). The imagers are predicted to respond more quickly to the statements concerning item appearance than the verbalisers, since they are more likely to represent items as mental pictures and will respond to appearance more rapidly. The verbalisers are expected to have shorter response times in the conceptual category statements because of their verbal abstract nature. Response times are recorded by the program and the verbal-

imagery ratio is calculated. A low ratio corresponds to a verbaliser and a high ratio to an imager. Additionally, since the participants have to read the verbal and imagery statements, reading ability or reading speed should not affect the final verbal-imagery ratio.

The second two subtests assess the wholist-analytic (WA) dimension, which contain coherent features with the measures of FDI cognitive style (see description in Chapter 2). The first of the two tests (i.e. overall the second subtest of CSA;  $n = 20$ ) requires participants to judge whether two complex geometrical figures are the same or not (see Figure 1.3). Half of the pairs are the same and half are not. It is assumed that the wholists would respond relatively faster in this subtest, because it involves the overall similarity judgment.



*Figure 1.3.* An example of wholist questions in CSA



*Figure 1.4.* An example of analytic questions in CSA

The second subtest (i.e. overall the third subtest of CSA;  $n = 20$ ) asks participants to compare a simple geometrical shape and a complex figure and decide whether the simple shape is contained in the complex one (see Figure 1.4). This task needs a degree of disembedding of the simple shape within the complex figure. Again, half of the stimulus



items expect “yes” responses and the other half expect “no”. Therefore, the analytics are hypothesised to react quicker at doing this.

Reaction times from the two subtests are recorded and calculated by the programme. Similarly, a low ratio corresponds to a wholist and a high ratio corresponds to an analytic.

The CSA is the first computerised test to assess the WA and VI cognitive style dimensions in an integrated manner. It now is the most popular computerised measure of cognitive styles in European universities and organisations (Peterson, Deary, & Austin, 2003). Riding and his colleagues have published over 30 peer-reviewed papers providing evidence of its theoretical support and practical application. They will be discussed carefully in the following subsection.

### *1.3.2 Reliability and Validity of CSA*

A substantial amount of research has been conducted on the relationship between observed behaviours and the application of CSA (see Riding, 1997; Riding & Rayner, 1998). Findings seem to provide good support. However, few studies have been reported concerning its psychometric parameters (e.g. reliability). This is unusual for such a popular measurement of cognitive style. In this section, the reliability and validity of the CSA will be discussed.

*Reliability.* Peterson et al. (2003), employing the original CSA test and a new parallel version to do the test-re-test, and split-half analysis, revealed a very low reliability of the VI dimension ( $r = .27$ , non-significant) and moderate reliability of the WA dimension of the CSA ( $r = .53$ ,  $p < .01$ ) (for  $n=50$ ). They replicated the finding later (Peterson, Deary, & Austin, 2005a). Similarly, three experiments with different time intervals (from one week to one month), which were carried out by Rezaei and Katz (2004), also reported low reliabilities of the VI test (range  $r = .30$  to  $.45$ ) and the WA test (range  $r = .42$  to  $.55$ ). Using two groups of third year undergraduates who were retested on

the CSA after either 14 days or 23 months, Parkinson, Mullally, and Redmond (2004) found a negative short-term test-re-test correlation for the VI test of CSA ( $r = -.19$ ); while the reliability increased to  $r = .36$  for the 23-month-interval. The test-re-test reliability is relatively stable for the WA test, which varied from .33 to .34. They concluded that these values are considerably below the generally acceptable values of  $r = .7$  (Kline, 2000). Albeit Riding (2005) argued that long-term test-re-test reliability studies are required to confirm those findings. Concerns are therefore still warranted, especially for the VI dimension of the CSA test.

These results clearly exhibit an unsatisfactory reliability for the VI dimension of the CSA. It also challenges the theoretical basis of the VI dimension of cognitive style. Compared to the WA dimension, the concept of the VI dimension has much less support, both theoretically and experimentally (Peterson et al., 2003). It may elicit the question: Is the low reliability caused by an un-suitable measuring technology, or more fundamentally, by its operational definition? This will be discussed further in Chapter 6; this chapter will merely consider the limitations of the measure of the CSA, which might affect its stability.

*Validity.* Riding (2003) admitted that (the low reliability of) the measurement is still the prevailing problem which limits the research of the VI dimension cognitive style. However, he insisted that it should not lead to a confusion of construct validity as there is strong evidence reporting the significant relationship between the dimension itself and recorded behaviours. He referred to Richardson's discussion (1994, p. 11) that the VI dimension of cognitive style is "...a genuine phenomenon that has psychologically significant consequences. These consequences define its adaptive functions".

Riding (2005) has published considerable evidence to claim the construct validity of CSA. It contains three aspects. First is the distinction from other individual differences, such as intelligence (Riding & Pearson, 1994), common personality measures (Riding &



Wigley, 1997) and gender\* (Riding, 1997). Second aspect mentions the correlates with physiologically based measures (Riding, Glass, Butler, & Pleydell-Pearce, 1997; Riding & Rayner, 1998; Glass & Riding, 1999). Finally, he emphasises its relation with numerous observed behaviours (see review in Riding & Rayner, 1998).

In contrast, a few studies exhibited negative evidence of the construct validity of CSA by demonstrating low correlations between the two style dimensions with their theoretically related measures. For instance, Coffield, Moseley, Hall and Ecclestone (2004) reviewed a number of style related constructs and reported very low correlations (even close to zero) between the dual dimensions of CSA and other measures. Those measures even include WA/VI family related style labels, such as the intuition-analysis dimension of Allinson and Hayes' (1996) Cognitive Style Index (CSI).

Furthermore, K. Garland (personal communication, March 26, 2006) has revealed non-significant correlations ( $r$  values below 0.27) between the WA dimension of the CSA and either the Embedded Figures Test (EFT) and the Grouped Embedded Figures Test (GEFT) (the two main measures of the FDI cognitive style, which will be described in Chapter 2). This is a rather unexpected finding. According to the theoretical and operational consistency between the FDI cognitive style and the WA dimension of style, as Riding and his colleagues admitted (e.g. Riding & Pearson, 1994; Riding, 2005), it could be inferred that the two constructs should exhibit a high correlation given the significant overlap. However it was not found to be the case by Garland. It might be a considerable challenge to CSA's (WA test) construct validity. Whereas the sample size in the Garland's study is relatively small for an individual difference study ( $n = 48$ ), more evidence is required to clarify this problem. Thereby, the author employed a study with a larger sample size to re-examine the relationship between the FDI style and the WA style. It will

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\* Although Riding argued that the two dimensions of cognitive style are independent from gender, there were a couple of reports of gender difference on the WA dimension; women (occasionally) appear more wholist than men. See section 1.3.3 for more discussion.



be covered in Chapter 2.

Nevertheless, the unsupportive results for validity may partially contribute to the low reliability of the CSA measure. Although Riding (2003) declared that it is possible that a test with low reliability is valid, there is not enough evidence to prove what he said. Rather, it may lead to doubt concerning its reported validity. For example, as part of the construct validity, the independence of CSA with other unrelated constructs such as personality, gender, and intelligence could be attributed to the unreliable data from the CSA (Rezaei & Katz, 2004). Thus, it is necessary to think over the limitations of the CSA.

### *1.3.3 CSA Findings in the Thesis*

The data of a number of 383 participants (121 men, 262 women)<sup>†</sup> who have been tested by the CSA in the present thesis is shown here. The overall mean WA ratio of the present sample was 1.17 (SD 0.34), and the overall mean VI ratio was 1.03 (SD 0.12). Both means were slightly below Riding's (2005) main standardised sample but not by very much (WA  $1.25 \pm 0.45$ , VI  $1.06 \pm 0.20$ ). This might be due to different samples of participants. Riding's (2005) standardised sample of CSA contains a wide range of individuals (e.g. age, gender, occupation) while the present sample mainly consists of university students. The correlation between the two dimensions (WA and VI) of cognitive style replicated previous findings and was non-significant ( $r(383) = 0.058, p > .25$ ), supporting the independence between them. However, the gender difference in the WA cognitive style ratios was found significant,  $t(381) = 2.81, p < .01$  (men  $1.24 \pm 0.39$ , women  $1.13 \pm 0.31$ ). This finding is consistent with the gender difference, which was reported in Riding's (2005) standardised sample, although Riding (1997; 2005) insisted no gender bias should exist in cognitive styles. Hence, in each of the following studies gender

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<sup>†</sup> In order to purify the present sample into a mainly native English speakers group, the sample of 383 participants did not include the 40 Chinese participants mentioned in Chapter 3. Besides, there were some participants who have attended more than one studies of the thesis, but their cognitive style data had not been repeatedly recorded. Thus, this number looks smaller than the sum of the numbers of participants of each study.

would be tested in advance as a possible confounding variable in order to avoid any confusion. In contrast, men ( $1.04 \pm 0.13$ ) and women ( $1.03 \pm 0.11$ ) demonstrated similar mean ratios of the VI dimension of cognitive style ( $t(381) = 0.29, p > .77$ ).

#### *1.3.4 Criticisms of CSA*

With regard to the stimuli used in the CSA test and the administration guide of the CSA, as well as the author's own experience of the administration of the test, several criticisms of the CSA have arisen.

First, the questions of the VI test of the CSA (e.g. "OAK and BEECH are the same type" or "LETTUCE and LAWN are the same colour") are rather 'subjective'. This may introduce additional variation in responses to the VI questions. Additionally, some statements of the VI dimension of the CSA have been reported to be confusing by participants. For example, some participants did not think "ICE" and "GLASSES" are the same colour since glasses are transparent and "ICE" is a name of a colour, which is light blue (Zhang, 2004). However, the CSA feedback states that they are the same colour. In another instance, a statement asks that whether "BEANS" and "CHICKEN" are the same type. There is some ambiguity here. If they are both food, the answer is 'yes'; but beans could be classed as a plant and chicken is an animal, and so the answer is 'no'. Thus, there might be incongruence of the concepts between participants and the test designer. Similar comments have been made by Peterson et al. (2004).

Secondly, as Riding claimed, normal people are able to employ both verbal and imagery modes of representation and this dynamic feature may lead to the VI processing being sensitive to the environment. That is, the VI mode could be easily switched with regard to the design of the stimuli and shows less stability compared to the WA dimension. As stated, the measure of the VI dimension of the CSA uses a word-based task to assess both verbal and imagery styles. This is inappropriate given that individuals need to read



the statement (in words) first to make the judgement. All participants may all first be aroused to a verbal coding rather than an imagery coding as Riding (1991) expected in the imagery task. In addition, Riding has not provided any information about how he matched the words used in both verbal and imagery questions, for example word frequency, word familiarity, word imageability (the ease with which a word arouses a mental image), etc. Nevertheless, linguistic research has shown that these factors would significantly affect people's performances on lexical tasks (e.g. Weekes, 1997). In short, the final results of the VI test of the CSA will probably be confounded by the stimuli used. And this could be responsible for the low reliability of the VI test of CSA.

Furthermore, there are also concerns about the overall administration of the CSA test. These include:

- 1) The ambiguity of the instructions may lead to participants being uncertain about their responses. According to the administration guide of the CSA, participants are required to work at their 'own rates'. This is in order to assess people processing information in a comfortable, relaxed state (Riding, 2005). Although it seems to be legitimate, participants' response speeds may vary a great deal depending on their understandings of the instruction. For example, some would be very cautious and spend more time ensuring they react correctly while some would place the emphasis on speed and respond very quickly. Save a natural style tendency, those temporary states could influence the final output of the test a great deal. It has been argued that if instructions concerning speed and accuracy were stated differently, then the way in which individuals process information would possibly change. Rezaei and Katz (2004) have reported a finding that when participants were told that their response times were important, the reliability of both WA and VI dimension of the CSA increased. Hence, this may be one of the ways to increase the reliability of the CSA.

2) Rezaei and Katz (2004) argued that the result of the CSA was sensitive to reaction times and temporary interruptions during testing. This is partly due to the fact that the 'Result File' of the CSA does not display the individual reaction times on each item. Researchers have no way to detect or eliminate extreme data from the calculation of the ratios. More details of the 'Result File' would be useful such as whether the item has a correct response and its individual reaction time. Such a change will not only promote the stability of the test, but also provide researchers with more detailed information for analyses and broader possibilities for research (e.g. the split-half reliabilities).

And the limited number of questions of each section (WA/VI) of the test is not enough to balance the biased result (i.e. reaction times are usually very short, thus even a single time delay caused by random interruptions could be influential for overall means). The general rule is that the longer a test is, the more reliable it will be. Adding more stimulus items might sufficiently increase the stability of the test of the cognitive style.

Rezaei and Katz (2004) also criticised the use of reaction time means to calculate final style ratios. However in the latest version of CSA (Riding, 2005), the program has employed 'medians' for style ratio calculations, which are much less (statistically) sensitive to outlier values.

3) During the administration of the CSA, several participants reported that they pressed the wrong button during the first part of the test. Additionally, participants also reported a 'learning' process in the VI section of the CSA. That is, they misjudged the statements at the beginning by being too harsh or too lenient with the criteria (e.g. "Are ICE and GLASSES the same colour?"). But later after feedback, they modified their definitions and category standards throughout the test, to be accordant with the 'correct' answers.

These phenomena imply adding a practice phase to the test would be useful. A few



practice items will allow participants to become familiar with the stimuli, the tasks and responses; and should minimise the variation of reaction times from unfamiliarity.

4) Cultural differences have been found to play a role in the VI task of CSA, whereas Riding (2005) assumed CSA to be culture free in nature. Rezaei and Katz (2004) gave one example: in the test, fire engines are assumed to be red, although they are yellow in Canada. Similarly, Zhang (2004) found bias when applying the test with a Chinese group; for example, one VI question asked if a postbox and a strawberry are the same colour. The answer is supposed to be “yes” according to CSA, but in China (and parts of Europe) postboxes are green. Further, a Chinese student may never experience “custard” in China, so s/he does not know what it is. Thus, care needs to be taken when this test is being used outside of the UK.

## **1.4 Outline of Thesis**

In this chapter, Riding’s two dimensional cognitive style model and its computerised measurement (CSA) have been reviewed and evaluated. Currently, both the theory and the CSA test have enjoyed a great popularity in research and educational application in the UK. Educational psychologists have provided a number of findings relating to classroom practice to support its external validity. For example, there is evidence that children’s learning behaviour and attainment were improved through the inclusion of Riding’s cognitive styles in the teaching and learning processes in the classroom (Pearson, 2007). However, few studies have experimentally investigated its nature and the underlying mechanisms. Further, several findings have questioned reliability of CSA test (especially the VI test), and this probably increases the criticism of its validity.

The present thesis intends to add experimental evidence to this cognitive style model and

CSA. Investigations of cognitive styles and their effects are conducted in a laboratory setting. The results may help to both clarify and facilitate our understanding of the nature of the two dimensions of cognitive style. In Chapter 2, a study is reported to confirm the relationship between the WA and the VI dimension of cognitive style and their theoretically related constructs. The two experiments described in Chapter 3 reflect a close link between the WA cognitive style and attentional control ability in metalinguistic performances and its connection with the proficiency of language mastering. In Chapter 4, using a stereotypic paradigm, results demonstrate an effect of the WA cognitive style on memorising personality traits with/without pre-existing frameworks of the target. Chapter 5 investigates the impact of cognitive styles upon behaviours that relate to self concepts, such as egocentric perspective taking, empathy, and attachment. Results suggest wholists have an advantage in integrated bodily process and imagers are related to other-oriented perceptions. In Chapter 6, a more reliable substitute of the VI test of CSA was introduced in order to examine the validity of the VI cognitive style with an improved measurement. Finally in Chapter 7, a qualitative framework is proposed to accommodate the reported results, and an attempt is made to place these findings into a more general context.

The coverage of the contents (relating to either or both cognitive style dimension) is summarised in Table 1.1.

Table 1.1  
*Contents of each chapter*

|           | WA cognitive style  | VI cognitive style   |
|-----------|---|--|
| Chapter 1 | A general introduction and evaluation of the theory and measurement of the two dimensions of cognitive style by Riding and Cheema (1991)  |  |
| Chapter 2 | An investigation of the relationships between the two cognitive style dimensions and their theoretical relatives  |  |
| Chapter 3 | The impact of the WA cognitive style on varied attentional-control-required metalinguistic tasks for native and second language speakers  | -----  |
| Chapter 4 | The influence of the WA cognitive style on stereotypic memory formation   | -----  |
| Chapter 5 | An examination of differed effects of the two cognitive style dimensions on self concept related perceptions and behaviours, such as egocentric perspective taking, empathy, and attachment |  |
| Chapter 6 | -----   | A check of the construct validity of current VI cognitive style after its poor measure reliability has been controlled for |
| Chapter 7 | General discussion and conclusion of the results  |  |



## **CHAPTER 2. RELATIONSHIP BETWEEN STYLE CONSTRUCTS**

This chapter examined construct validity of Riding's (1991) two cognitive style dimensions by checking the inter-correlations between the WA and VI cognitive styles and their theoretically related constructs. The significant results complemented the supportive evidence to the construct validity of both style dimensions and brought further comprehension of the nature of styles. Details are given in the main contents of this chapter.

### **2.1 Introduction**

A substantial amount of research has been reported to establish the construct validity of the two dimensions of cognitive style (i.e. the WA and the VI dimension; Riding & Cheema, 1991). Evidence includes the independence from other unrelated individual difference constructs, the association with physiological measures, and the link with a range of observed behaviours (as discussed in Chapter 1). However, relatively fewer empirical studies are reported to demonstrate a relation between the two cognitive style dimensions and their theoretical family members. Here the term "family member/relative" refers to the two 'families' of the cognition-centred style research identified by Riding and colleagues (Riding & Cheema, 1991; Rayner & Riding, 1997; Riding & Rayner, 1998), who consequently summarised the WA and the VI dimension of cognitive style to represent these two families. Hence, their 'family members/relatives' always refer to those constructs who should theoretically feature or at least relate to each of the dimensions of cognitive style respectively (as stated in Chapter 1).

Generally, the construct validity should involve the correspondence with their theoretically overlapped constructs. Unfortunately, it is not sufficiently covered in previous studies (e.g. Riding, 2005).

Thus, this chapter aims to investigate the interrelationships between the WA and VI cognitive styles, and their theoretically related peers. If the high interrelations are demonstrated, the result can provide the complementary evidence to the construct validity of the two cognitive style dimensions. In this study, only those constructs which have strong supports in the literature (i.e. widely accepted typologies with valid resulting measures) were selected to examine the hypotheses. The chosen constructs were FDI cognitive style (Witkin, 1967) and the concrete-abstract dimension and the reflective-active dimension of learning style (Kolb, 1976).

### *2.1.1 Field Dependence/Independence*

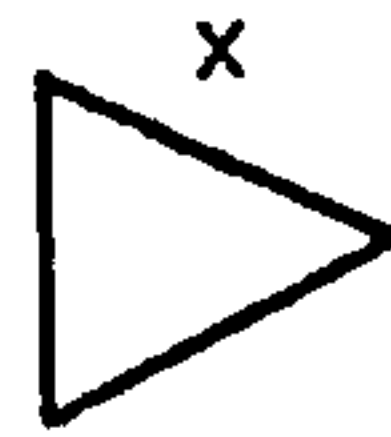
The theoretical kindredness between the FDI cognitive style and the WA dimension of cognitive style has been fully discussed in Chapter 1. In brief, the FDI cognitive style refers to the ability to 'disembed' an object from its environment. Thus, FDs tend to perceive representations and concepts at face value and prefer dealing with materials in a well-presented structure. In contrast, FIs are good at determining discrete items/details from their background and imposing structure on information.

Witkin (1967) initially developed the 'embedded figures test' to detect the FDI cognitive style by a perceptual task. This is a pencil and paper assessment including the disembedding of a shape from its surrounding field. Several variations were developed: the Embedded Figures Test (EFT) and the Grouped Embedded Figures Test (GEFT) are the two most well known ones. The EFT is administered on an individual basis and the GEFT is a group-administered test in order to allow group presentation of the EFT items. These are uni-dimensional tests and individuals are classified by their performances. That is, better performance equates to more FI. In the present study, the GEFT was selected as the measure of FDI cognitive style because of its better acceptance in the literature (see Witkin, Oltman, Raskin, & Karp, 1971). The GEFT consists of 25 items and people are required to

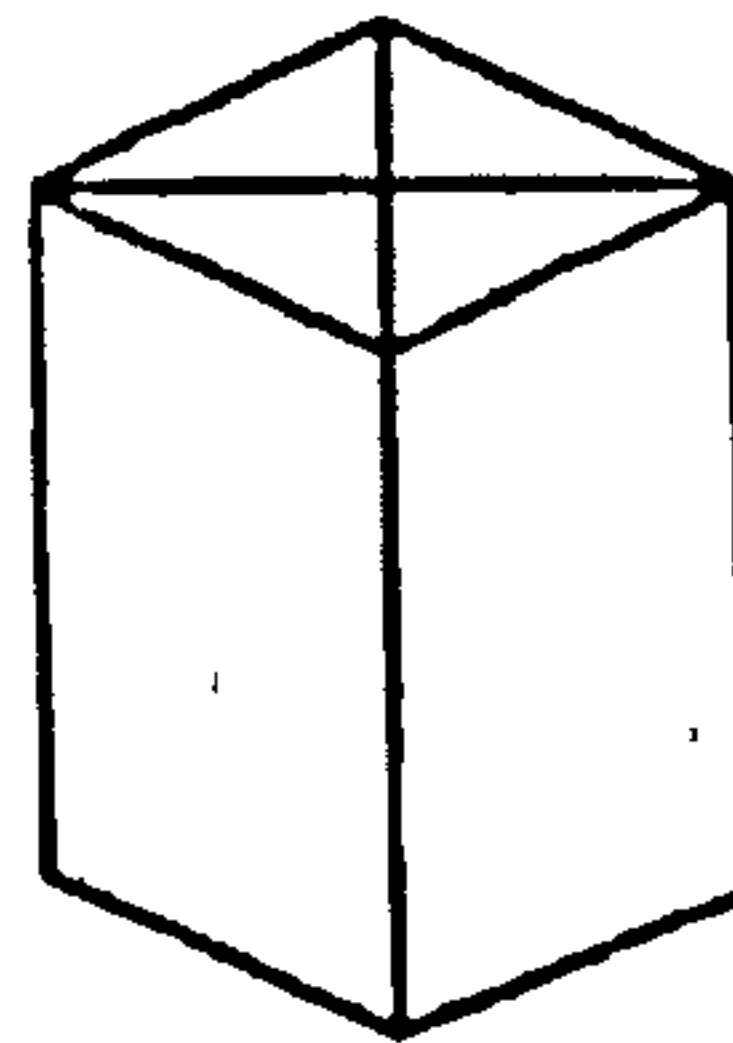


trace as many of the simple forms in the complex figures as possible within given times (see Figure 2.1).

Here is a simple form which we have labeled "X":



This simple form, named "X", is hidden within the more complex figure below:



*Figure 2.1.* Example of an embedded figure in GEFT

There are three sections in the GEFT: a practice section of seven items, followed by two sections of nine items each. Performance is decided by how many simple forms have been correctly traced in the last two sections (2 and 3). Sections 2 and 3 were considered parallel and the items were designed to be discriminative to increase the difficulties of performing the task (i.e. finding the simple form inside the complex figure). However, evidence has suggested that participants actually improve their performance from Section 2 to Section 3 (Cummings & Murray, 1987; Lusk & Wright, 1981; Panek, Funk, & Nelson, 1980). The finding cannot be explained by a simple learning or practice effect as a reversed order of the two sections did not counteract the effect (Kepner & Neimark, 1984). Kirchner, Forns, and Amador (1989) concluded that the improvement from Section 2 to Section 3 was resulting from the fact that latter is easier to solve compared to Section 2. For this reason, Section 2 and Section 3 of the GEFT will be analysed separately in order to monitor any differences.

The construct of FDI cognitive style has been well accepted in the literature, and generally manifests strong reliability and validity of the EFT and GEFT (see Witkin et al., 1971). However, there are critiques on the theory and measurement of FDI cognitive style that question whether this concept is actually reflecting a cognitive 'style' or cognitive 'ability'. Evidence purported a significant relationship between overall performance in EFT and GEFT and the general ability/'intelligence' of participants (see, Goldstein & Blackman, 1978; Flexer & Roberge, 1980; Messick, 1976; Paramo & Tinajero, 1990). For instance, correlational studies (e.g. Daku, 1978; Flexer & Roberge, 1980; Riding & Pearson, 1994) have indicated positive relations between measures of FDI cognitive style and various intelligence or achievement tests. If the FDI cognitive style does overlap with intelligence or abilities, it could result in a narrowed variance between the FDI cognitive style and the WA dimension of cognitive style. Riding (1997) has asserted that the WA dimension of cognitive style is "independent from intelligence" (p33). It might explain K. Garland's (personal communication, March 26, 2006) finding of the non-significant correlations between the EFT/GEFT and the WA test of CSA. Nevertheless, the small sample size ( $n = 48$ ) of the study has reduced the validity of Garland's result. Therefore the present study would consider this issue with a more reasonable sample size.

### *2.1.2 Experiential Learning Theory*

Kolb, Rubin, and McIntyre (1971) offered a model of the experiential learning progress. They considered learning was based on grasping and transforming experiences, and learning progress could be described as a cycle of action and reflection. Kolb (1984) extended these ideas to a new learning theory. He proposed that individuals learn and solve problems in a continual process of four distinct stages. These are shown in Figure 2.2. Concrete experiences (feeling stage) provide the basis for observations and reflections (watching stage), which further develop into theories (thinking stage), then from which



new actions are deduced (doing stage), and these lead to new concrete experiences (another feeling stage). Kolb believed that when one cycle of learning ends, a new cycle begins. So the learning process is continual (Duff, 2000). He also suggested that different abilities are required for each of the stages, and individuals tend to be more skilled in some stages than others, so that they could be grouped into different learning styles.

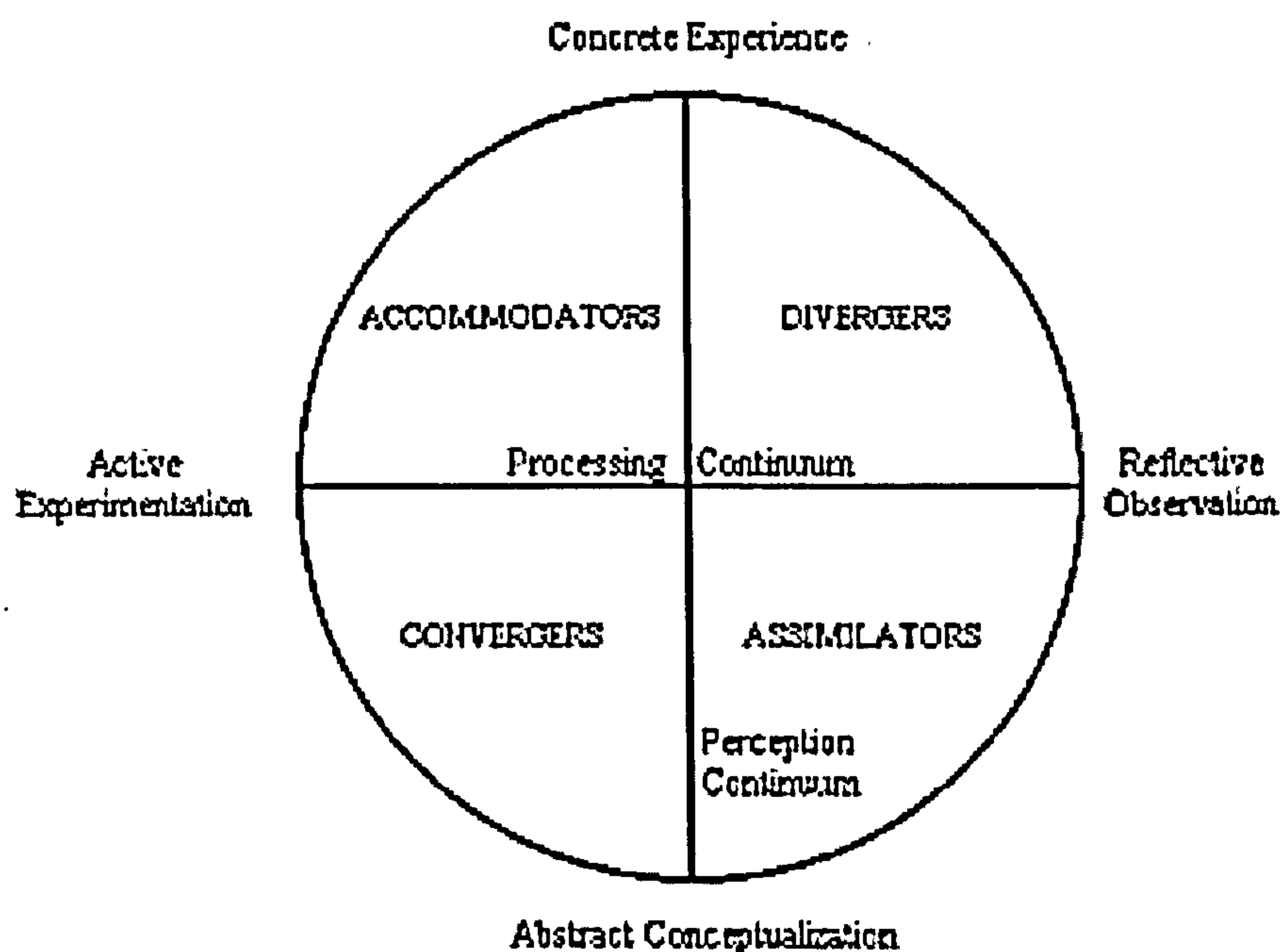


Figure 2.2. Kolb's (1984, p58) concept of the Experiential Learning Cycle

Kolb (1985) illustrated four types of learners corresponding to the four stages of the experiential learning: divergers, assimilators, convergers, and accommodators. They are shown in Figure 2.2, and were defined as follows:

1. Divergers tend to use approaches that include both firsthand experience and reflective observation, and perform best at viewing concrete situations from different points of view and gathering information.
2. Assimilators, who have detached observation and abstract conceptualisation preferences, feel most confident when they understand a wide range of information and formulate it into theories.

3.       Convergers, whose primary learning modes involve abstract conceptualisation and active experimentation, are good at problem solving and changing theory application into practice.

4.       Accommodators tend to learn by placing the emphasis on active experimentation and concrete experience, and are interested in planning new actions and emerging new experiences.

Two bi-polar dimensions of the cognitive growth (learning) have been proposed based on these learning styles: the reflective-active dimension and the concrete-abstract dimension. The two dimensions can be visualised by drawing lines across the learning circle (see Figure 2.2). The reflective-active dimension contains a range of behaviours from detached observation to direct participation. The concrete-abstract dimension involves preferences from dealing with concrete targets to handling theoretical concepts.

Kolb (1976) suggested that a 'learning style' refers to the way in which an individual acquires and uses information. He viewed learning style as a cognitive style that manifests itself in the learning environment. There is no formal suggestion indicating the relationship between Kolb's learning style and other cognitive styles, such as Riding's WA and VI dimensions. But the descriptions of the reflective-active dimension and the concrete-abstract dimension might imply this to be so. Kolb described the concrete experience stage as 'feeling' and suggested that individuals who prefer this stage would be more receptive, feeling, accepting, intuitive, and present orientated, rather than have a systematic approach to problems. This explanation seems congruent with the characteristics of wholists (and FDs) who tend to depend on the influence of a whole surrounding field when viewing information (Riding, 1997; Witkin et al., 1971). Kolb also labelled the abstract conceptualisation stage as 'thinking' and argued that the individuals who prefer the stage would be more analytical, thinking, evaluative, logical, and rational.



He regarded thinking as using logic and ideas over feelings to understand problems. This is coherent with the description of analytics (and FIs) who have the preference of detailed, processing information and are more adept at determining discrete fragments from context. Logically, it may lead to the conclusion that the concrete-abstract dimension should positively correlate with the WA dimension of cognitive style. Individuals' varied tendency on information organisation (the WA dimension of cognitive style) would affect their preferences for ways of learning, from concrete practice to abstract processing. The wholist individuals desire concrete experience while the analytic individuals prefer abstract conceptualisation.

However, Leonard, Scholl and Kowalski (1999) reported a negative correlation between the concrete-abstract dimension and the GEFT scores, which pointed the aptitude of FDs (wholists) to abstract conceptualisation and the tendency of FIs (analytics) to concrete experience. It is rather opposite to the predicted direction. Although Leonard et al. (1999) suggested that both the concrete-abstract and FDI dimension reflected the extent to which individuals use and develop theoretical constructs, they failed to provide an explanation about why such a relation exists. Their finding will be discussed further in the discussion section of this chapter.

Moreover, the 'thinking' stage (abstract conceptualisation) seems to favour the advantage of verbal nature (Zhang & Noyes, 2007), while the 'feeling' stage (concrete experience) is consistent with an imagery representation mode (Riding & Rayner, 1998). Riding (2005) claimed a family relationship between the VI cognitive style and the abstract-concrete dimension by Harvey, Hunt, and Schroder (1961). Although the two concrete-abstract dimensions are not necessarily the same, this discussion provides more inference of relationship between the Kolb's concrete-abstract dimension of learning style and Riding's VI dimension of cognitive style. The VI dimension of cognitive style is

mainly about whether an individual tends to represent knowledge language-like or picture-like. On one hand, verbal representations, which are language-like, are characterised as being propositional and referentially arbitrary. Thus, they have to be conceptualised from the outside world and become arbitrarily abstract. On the other hand, the term 'picture-like', which refers to properties such as analogue, isomorphic, graphic, and so on, implies that the representations reflect the represented targets in a more accurate and concrete way. Accordingly, it is logical that individuals' tendency to use verbal or imagery manner of representation correlates with their preference of dealing with abstract concepts or concrete targets.

The reflective-active dimension decides whether individuals rely on one's own feeling and thoughts to form opinions or enjoy interactions with others and the external world. The study of Leonard et al. (1999) demonstrated that this learning style dimension is independent from FDI cognitive style; hence, the WA cognitive style. In addition, Riding and Rayner (1998) have commented that there are aspects of the VI cognitive style that may affect the focus of individuals' behaviours. Accordingly, verbalisers might appear more externally focused because the 'language-like' representation manner encourages them to communicate more with others. While imagers might appear more internally focused, as the imagery representation does not necessarily require interaction with the outside world. Inferentially, the VI cognitive style may link to the reflective-active dimension of learning style.

In order to determine the learning styles of an individual, Kolb (1971) developed a measure named the Learning Style Inventory (LSI). It was originally a self-descriptive forced-choice questionnaire comprising 9 items. Each item contains four words that are required to be ranked according to how well it characterises one's learning preference. Each word in each set corresponds with a learning orientation (feeling, watching, thinking,



and doing). It was later revised in 1985, 1993 and 1999 to include 12 items instead of 9.

In the LSI (Kolb, 1993), four scales are calculated. Each of them relates to one of the learning abilities: concrete experience (CE), reflective observation (RO), abstract conceptualisation (AC), and active experimentation (AE). Using these scores, two more scores can be computed: AE minus RO, indicates an individual's position on the reflective-active dimension (AERO); while AC minus CE, indicates a composite score on the concrete-abstract dimension (ACCE). The scores show an individual's preferences along the two continual dimensions (reflective-active and concrete-abstract), and hence indicate which learning stage is preferred.

Kolb's experiential learning style theory has been widely accepted. However the utility of the LSI have attracted some questions (Duff, 2000). For example, Wilson (1986) re-analysed three versions of the LSI, and found an inconsistency of factors with those Kolb predicted. James (1980) and Wilson (1986) critically discussed the questionnaire in terms of the classification of items, the interpretation of words, and the difficulty in understanding a number of items. Other criticisms focused on its reliability and construct validity (Duff, 2000). In sum, findings of the reliability and validity of LSI earlier versions have been mixed (Allinson & Hayes, 1988).

With these criticisms in mind, the most recent version of the LSI (Version 3.1, 2005; see Appendix A) was selected for this study. The validity and reliability of the 2005 LSI proved to be much better than its pioneers. Studies have shown good internal consistency ( $r > .7$ ) of LSI 3.1 in either the overall scale or the subscales across a number of populations (Kayes, 2005; Kolb & Kolb, 2005; Ruble & Stout, 1990, 1991; Wierstra & DeJong, 2002). The test-retest reliability of LSI 3.1 ranged from moderate to excellent ( $r \approx .54$ , Ruble & Stout, 1991;  $r > .9$ , Veres, Sims, & Locklear, 1991). Construct validity of LSI 3.1 was also reported to be satisfactory (see Kolb & Kolb, 2005).

### *2.1.3 Hypotheses*

According to the above review, three general dimensions of style can be identified:

1) how individuals tend to organise information, globally or analytically; 2) how individuals tend to represent information, verbally/theoretically or imagery/concretely; and this second dimension probably relates to the third dimension that 3) whether individuals obtain and process information through interaction with others and the external world, or in an isolated internal process.

Individuals who are on one end of the first dimension tend to have a holistic impression of information. In contrast, individuals at the other end of this dimension tend to view information as a collection of units. The WA and the FDI cognitive style evidently manifest this common dimension. The concrete-abstract dimension, as discussed, should be conceptually related to it. It is therefore hypothesised that:

H1. The WA ratios and the GEFT scores will be positively correlated.

H2. The WA ratios and ACCE scores will be positively correlated. Moreover, the WA ratios will positively correlate with AC scores but negatively correlate with CE scores.

The second dimension, the preferred representation mode, is reflected in Riding's VI dimension. Because of the nature of verbal and imagery representation, there is the possibility that individuals favour different learning stages with regard to their VI style and make the concrete-abstract (ACCE) dimension relevant to this style dimension. Therefore, it is hypothesised that:

H3. The VI ratios and ACCE scores will be negatively correlated. Further, the VI ratios will negatively correlate with AC scores but positively correlate with CE scores.

In addition, the first two dimensions of style are expected to distinguish from each other according to Riding (1997). That is, the VI style should be independent from both the WA style and FDI style.



The final dimension of whether individuals interact with others and the external world to obtain and process information is captured in the reflective-active (AERO) dimension. This dimension may be theoretically independent from the WA dimension but related to the VI dimension of cognitive style. Hence, the following hypothesis is devised:

H4. The VI ratios and AERO scores will be negatively correlated. Further, the VI ratios will negatively correlate with AE scores but positively correlate with RO scores.

Additionally, Kolb and Kolb (2005) have announced the independence between the active-reflective (AERO) dimension and the concrete-abstract (ACCE) dimension of learning style. Hence, no correlation between the two scores is expected.

## **2.2 Method**

### *2.2.1 Design*

The study is a correlational design. Participants' scores of the GEFT, CSA, and LSI tests were treated as independent variables.

### *2.2.2 Participants*

Ninety-nine undergraduates (33 males, 66 females) enrolled in psychology courses at the University of Bristol attended the study in return for receiving course credits. Participants had an average age of 20.7 years with SD 5.67 years (range from 16 to 58 years). All participants were reported as native English speakers.

Among them, 83 participants completed the GEFT, CSA, and LSI tests. The remaining 16 participants completed the CSA and LSI only.

(The data of these 16 participants was a result of a filling task of another study. There is a series of cognitive style studies presented in this thesis that required a completion of the CSA to gain their cognitive style ratios. However, in order to avoid relevant confounding effects, those repeated participants (who attended more than one of

the studies) did not perform the CSA more than once. Hence they completed the LSI as a time filling task instead of CSA in a memory-recall experiment (details see Chapter 4), and their results are included in the present chapter.)

### *2.2.3 Materials*

The experiment materials included the computer-based version of CSA (Riding, 1991), GEFT booklets (with pencils for tracing the simple shapes), LSI questionnaires, and a stopwatch.

### *2.2.4 Procedure*

Participants were tested individually and uninterrupted in a quiet room. They began by completing the GEFT. They were required to read the instructions on the first three pages of the booklets, which included two example problems. Then they were told to perform seven problems in Section 1 in 2 min (as measured by the stopwatch). After that, they were given 5 min each for Sections 2 (nine problems) and 3 (nine problems).

Participants were required to use pencils to outline the simple forms out of the complex figures. All the simple forms were printed on the back cover of the booklets so that participants would not see them and complex figures (where to outline the simple forms out) at the same time. If participants did not complete problems in a particular section in the required time, no extra time was allowed, and they would move to the next section.

Then participants carried out the 12-item self-report LSI questionnaire by ranking their preferences to each question.

Finally, the CSA test was administered with instructions appearing before each of the three sections on the computer. The test is self-paced and participants were given feedback about their cognitive styles at the end of the test (including their ratios on each cognitive style dimension).

Upon completion of all three tests, participants were thanked and debriefed.



### **2.2.5 Data Analysis**

Participants' positions on the WA and VI dimension were indicated by ratios of reaction times corresponding to different task questions. A low ratio (e.g.  $< 1$ ) always refers to a wholist or verbaliser and a high ratio refers to an analytic or imager. Scoring of GEFT was given by the number of simple forms (out of a possible 18) that correctly outlined the complex figures in Sections 2 and 3 in the allocated times. The LSI was assessing six variables; four primary scores (AE, RO, AC, and CE) that measure participants' preferences on the four learning orientations, and two combination scores that measure participants' preferences for action over reflection (AERO) and abstractness over concreteness (ACCE) in learning.

The data was initially checked for gender differences. To examine a possible gender effect on cognitive styles, three separate one-way analyses of variance (ANOVAs) with gender (men versus women) as the between subject factor, were conducted on the FDI scores and the WA and the VI ratios. The results revealed no significant differences between men and women (all  $p > .05$ ). It implied that gender was not a confounding factor with the cognitive style dimensions in the present study. As a result, it would not be taken into consideration in the analysis.

## **2.3 Results**

The descriptive statistics for the CSA, GEFT, and LSI scores are reported in Table 2.1.

Pearson correlations have been conducted on the eleven scores from the three tests. The correlation statistics are shown in Table 2.2. The results are described in four separate subsections according to the hypotheses.

Table 2.1  
Descriptive statistics of CSA, GEFT, and LSI scores

|       | WA     | VI     | GEFT           | GEFT            | GEFT            | AE     | RO     | AC     | CE     | AERO   | ACCE   |
|-------|--------|--------|----------------|-----------------|-----------------|--------|--------|--------|--------|--------|--------|
|       | ratios | ratios | overall scores | Section2 scores | Section3 scores | scores | scores | scores | scores | scores | scores |
| Means | 1.16   | 1.04   | 15.17          | 6.88            | 8.34            | 33.14  | 27.94  | 34.78  | 24.14  | 5.20   | 10.64  |
| SD    | 0.34   | 0.11   | 2.19           | 1.65            | 0.99            | 6.95   | 6.32   | 7.61   | 6.31   | 11.39  | 12.19  |
| Min.  | 0.04   | 0.75   | 9              | 2               | 5               | 16     | 16     | 16     | 12     | -23    | -27    |
| Max.  | 2.71   | 1.36   | 18             | 9               | 9               | 45     | 45     | 48     | 45     | 24     | 32     |
| N     | 99     | 99     | 83             | 83              | 83              | 99     | 99     | 99     | 99     | 99     | 99     |

Note. WA ratios = wholist-analytic ratios of CSA; VI ratios = verbal-imagery ratios of CSA; GEFT = the Grouped Embedded Figures Test; AE = active experimentation subscale; RO = reflective observation subscale; AC = abstract conceptualisation subscale; CE = concrete experience subscale; AERO scores = composite scores on the reflective-active dimension; ACCE scores = composite scores on the concrete-abstract dimension.

Table 2.2  
Correlations between scores from CSA, GEFT, and LSI

| Variables     | WA      | VI     | GEFT   | GEFT   | GEFT  | AE      | AERO    | ACCE    | AE      | RO      | AC |
|---------------|---------|--------|--------|--------|-------|---------|---------|---------|---------|---------|----|
|               | Overall |        |        |        |       |         |         |         |         |         |    |
| VI            | -0.08   |        |        |        |       |         |         |         |         |         |    |
| GEFT Overall  | 0.26*   | 0.04   |        |        |       |         |         |         |         |         |    |
| GEFT Section2 | 0.23*   | 0.13   | 0.90** |        |       |         |         |         |         |         |    |
| GEFT Section3 | 0.15    | -0.12  | 0.71** | 0.35** |       |         |         |         |         |         |    |
| AERO          | -0.00   | 0.01   | -0.06  | -0.01  | -0.14 |         |         |         |         |         |    |
| ACCE          | 0.19†   | -0.24* | 0.12   | 0.05   | 0.16  | -0.03   |         |         |         |         |    |
| AE            | 0.02    | 0.03   | -0.12  | -0.05  | -0.17 | 0.87**  | -0.13   |         |         |         |    |
| RO            | 0.03    | 0.01   | -0.03  | -0.04  | 0.06  | -0.84** | -0.09   | -0.47** |         |         |    |
| AC            | 0.13    | -0.21* | 0.16   | 0.08   | 0.18  | -0.07   | 0.90**  | -0.37** | -0.27** |         |    |
| CE            | -0.21*  | 0.21*  | -0.04  | 0.01   | -0.09 | -0.03   | -0.85** | -0.19   | -0.15   | -0.53** |    |

Note. \*  $p < .05$ ; \*\* $p < .01$ ; † Approaching significance for the correlation between WA ratios and ACCE scores.



### 2.3.1 The Wholist-Analytic Dimension

The first two hypotheses (H1 and H2) tested the inter-correlation of style difference measures that conceptually relate to information organisation. In testing H1, the correlation between the WA ratios and GEFT scores were found significant ( $r(83) = 0.26, p < .05$ ). H1 was therefore supported. However, when investigated further, it was found that the WA ratios only significantly correlated with the GEFT Section 2 scores ( $r(83) = 0.23, p < .05$ ) and not with the GEFT Section 3 scores ( $r(83) = 0.15, p > .05$ ).

The frequency diagrams of performance in GEFT Section 2 and 3 are stated in Figures 2.3 and 2.4, which apparently exhibit the ceiling effect in Section 3.

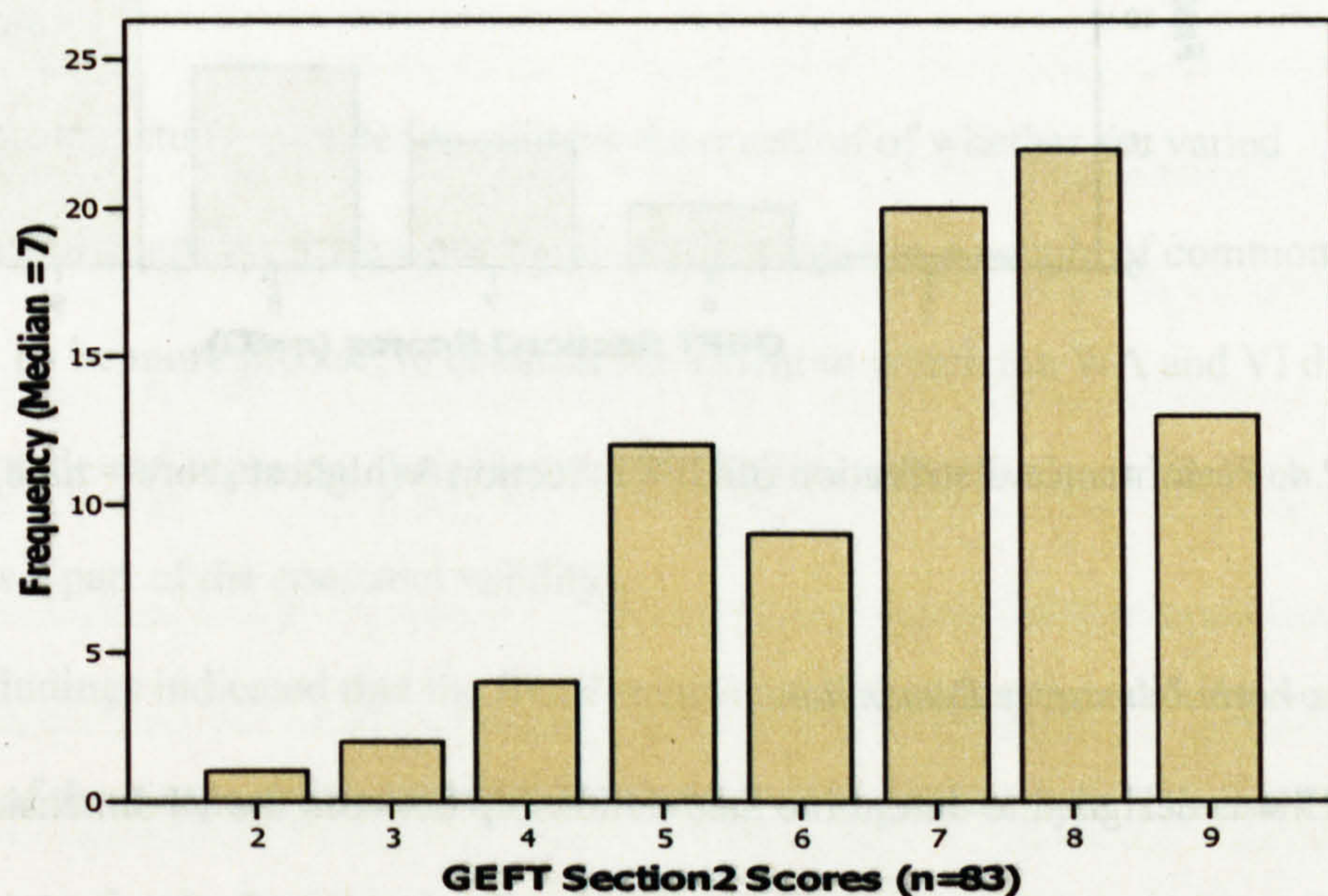


Figure 2.3. Performance distribution of GEFT Section 2 (highest score = nine)

The relationship between the WA ratios and ACCE scores was found marginally significant ( $r(99) = 0.19, p = .055$ ) in the predicted direction. Furthermore, when testing the relationship between the WA ratios and two primary scores of the ACCE dimension (AC and CE score), a significant correlation with CE score ( $r(99) = -0.21, p < .05$ ) was



revealed but not with the AC score ( $p > .05$ ). So H2 was partly supported in that individuals who tend to be more holistic prefer the concrete experience learning rather than those who tend to be more analytic. However, the WA style did not affect their preference on the abstract conceptualisation learning.

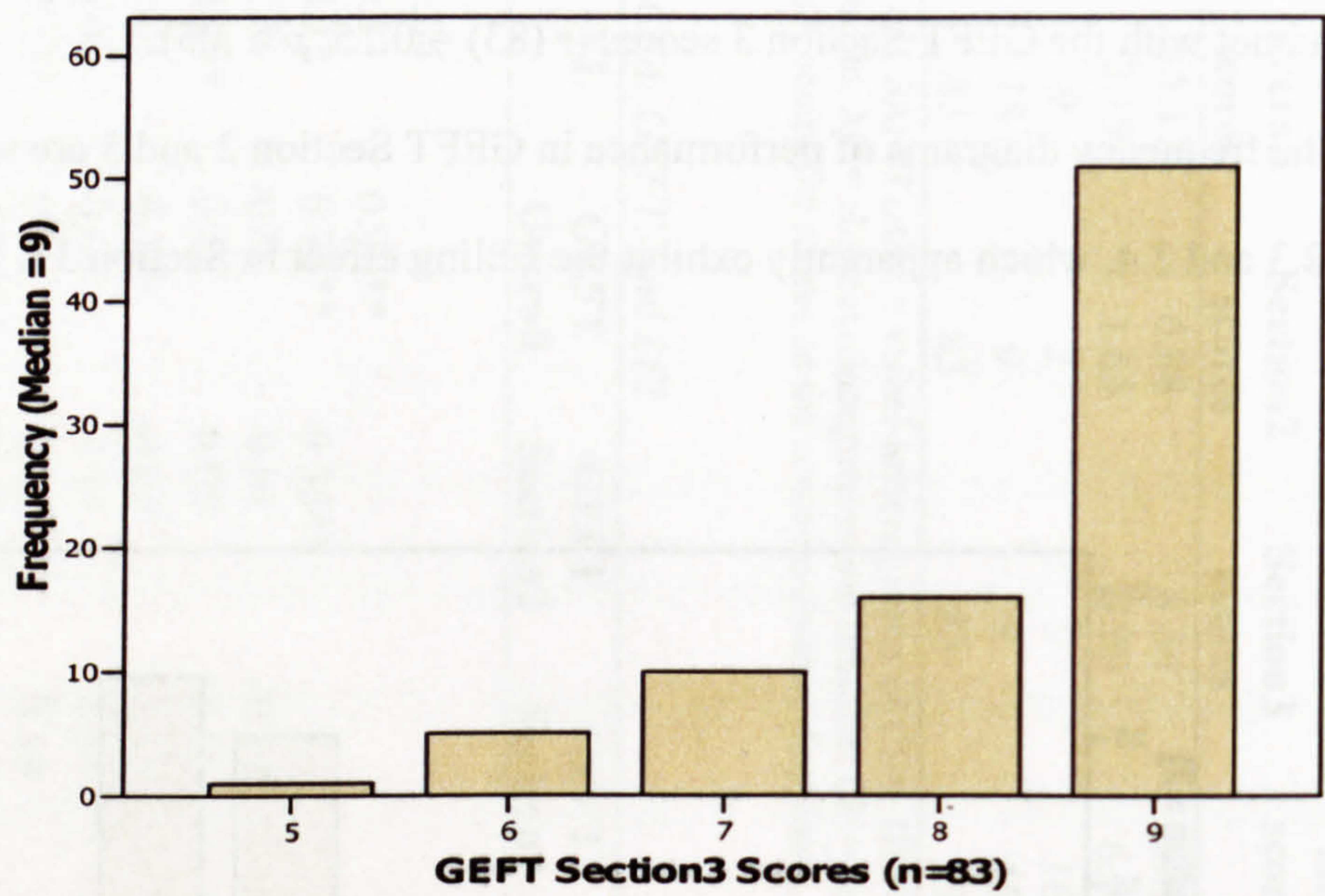


Figure 2.4. Performance distribution of GEFT Section 3 (highest score = nine)

2.3.2 The Verbal-Imagery Dimension

H3 was designed to determine the relationship between the VI dimension, which reflects the way in which an individual prefers to represent information, and the ACCE dimension, which involves a person’s preference for dealing with concrete materials or dealing with abstract concepts. The correlation was significant in the predicted direction ( $r(99) = -0.24, p < .05$ ) indicating that the more verbal individuals are, the more abstract conceptualisation they prefer, and the more imagery-oriented individuals are, the more concrete experiences they prefer. This hypothesis was further supported by two correlations between (both in the predicted directions) the VI dimension and the two



primary scores: AC ( $r(99) = -0.21, p < .05$ ) and CE ( $r(99) = 0.21, p < .05$ ).

### *2.3.3 The Reflective-Active Dimension*

The AERO dimension has been found not to correlate with any of other cognitive style dimensions (i.e. WA, VI, FDI), all  $p > .05$ . H4 was therefore not supported.

### *2.3.4 Independence between the WA and VI Dimensions and Independence between the ACCE and AERO Dimensions*

The relationship between the WA ratios and the VI ratios was found to be independent ( $p > .05$ ), as was the relationship between the FDI scores and the VI ratios ( $p > .05$ ). The correlation between the AERO dimension and ACCE dimension was also non-significant ( $p > .05$ ).

## **2.4 Discussion**

The present study intended to address the question of whether the varied measurements of cognitive style were significantly related to a couple of common dimensions. To be more precise, to consider the extent to which the WA and VI dimension of cognitive style can represent their theoretical families respectively as has been purported (as a part of the construct validity).

The findings indicated that the five dimensions of the measures did inter-correlate on the basis of three separate conceptual dimensions of cognitive style. They will be discussed in turn from subsection 2.4.1 to 2.4.4.

### *2.4.1 The Wholist-Analytic Dimension*

The first one, represented by the FDI style and WA cognitive style, reflects whether individuals prefer to view the information globally or analytically. This perceptual-analytical dimension of cognitive style has been well established in the literature where numerous models have been suggested to be theoretically related to this dimension of cognitive style (see Chapter 1). The positive significant correlation between the FDI scores

and the WA ratios empirically confirmed the conceptual overlap between the FDI cognitive style and the WA dimension of cognitive style. Individuals who are good at separating parts from their background or context, tend to organise information in a loose collection of discrete parts rather than a whole. In contrast, individuals may find it difficult to disembed pieces from the 'field' because they view information in a holistic manner. This result may contradict K. Garland's (personal communication, March 26, 2006) finding of the non-significant relationship between the FDI and the WA cognitive style because of the larger sample size.

However, it needs to be noted that the correlation between the GEFT scores and the WA ratios were only around .3 though significant. There are two potential explanations for this moderate correlation. First, it is because of the differentiation between the constructs of FDI style and the WA style. The FDI cognitive style, as mentioned in the introduction, has been questioned concerning how much its approach assesses style. The FIs were consistently found to perform better than FDs in the tests of intelligence (e.g. Goldstein & Blackman, 1978; Flexer & Roberge, 1980; Riding & Pearson, 1994). So the FDI construct is argued to involve the element of 'ability' rather than 'pure' style. In contrast, Riding's WA dimension of cognitive style has been defined as being a pure style and intelligence free (see Riding & Rayner, 1998). Reflecting on their measures, the GEFT may assess not only the tendency but also the ability for individuals to separate objects from their environment. In comparison, the WA test of CSA merely assesses tendency by assessing both ends of the dimension continuum and is not related to intellectual constructs (Riding, 2005). For this reason, although the FDI cognitive style and the WA dimension of cognitive style are conceptually very much related, there are unshared variances between them (i.e. a general ability factor) and hence their correlation with each other is weakened.

Secondly, the moderately low correlation can be contributed to the assessment of



GEFT itself. The GEFT has been chosen as the measurement of the FDI cognitive style because of its popularity, which is based primarily on the convenient administration. GEFT is calculated on how many items can be worked out in a given time to represent one's rank on the FDI cognitive style dimension. EFT or the WA tests of CSA, in contrast, employ reaction times as the indicator of participants' tendency on this perceptual-analytical dimension of cognitive style. EFT simply records a participant's reaction latency for each disembedding problem. The cognitive style ratios of CSA are also generated based on reaction times. Thus, they are both reaction time sensitive. Compared to EFT and CSA, the method used by GEFT probably introduces a ceiling effect into participants' responses of the GEFT test by setting an upper limit for participants' performance. Even when participants have performed all the problems before the time limits, they cannot get extra marks. The current study's participant sample is comprised entirely of university students, who could be considered to be the more capable participants among the whole population. It is therefore not surprising to find a ceiling effect existing in the present finding (see Figures 2.3 and 2.4). Such a ceiling effect possibly compromised the correlation within the tests. For example, Participant A accomplishes the test just in time, and Participant B completes the test 2 min earlier. According to GEFT, they both scored the highest score of 18. In this case, the difference between Participants A and B on this dimension of cognitive style has been concealed. However, Participants A and B are able to demonstrate different reaction times and thus reveal different scores in CSA and EFT.

Probably for this reason, the GEFT and other measurements of the FDI cognitive style have been reported to correlate low. For example, Goldstein and Blackman (1978) reported the GEFT correlated with its original instrument, the Rod and Frame Test, only in a medium range, .30 – .65. And K. Garland (personal communication, March 26, 2006) also found a non-significant relationship between the EFT and GEFT.

Concerning the present study, although both the scores of the two sections were highly correlated with the overall GEFT scores ( $r$  values range from .71 to .90), the relation between the two sections was only moderate ( $r = .35$ ). In addition, the scores of GEFT Section 2 were moderately related to the WA ratios ( $r = .23$ ), however the scores of GEFT Section 3 failed to correlate with the WA ratios ( $r = .15$ ; see Table 2.2). The reason is apparent in comparison between Figures 2.3 and 2.4, where there was an evident ceiling effect in the responses of Section 3. It is consistent with Kirchner et al. (1989) and their conclusion that Section 3 is easier than Section 2, and consequently the ceiling effect impairs the demonstration of the relationship between the GEFT (especially Section 3) scores and the WA ratios.

Moreover, the positive correlation between the WA ratios and the ACCE scores only reached a marginal significance and the hypothesis that the more wholist individuals are, the more concrete experience they prefer and the more analytic individuals are, the more abstract conceptualisation they prefer has not been fully supported. Nevertheless, this result did not support the finding of Leonard et al. (1999) of a negative correlation between the ACCE and GEFT scores. Considering the non-significant correlation between the ACCE and GEFT scores (but positive  $r$  values) in the present study, the confounding effect probably came from the GEFT test itself rather than the WA dimension of cognitive style.

The correlation between the WA ratios and the CE scores was found to be significant in a negative direction. This supported the hypothesis that wholists, who have the preference of intuitive situations and focusing on the problem as a whole and ignoring details, would be at an advantage in the 'feeling' stage of learning with first-hand concrete experience. Notwithstanding, individuals' position on the WA dimension of cognitive style did not affect their skilfulness in the 'thinking' stage (AC) of learning. The distinction is thought to be attributed to an environmental factor. A core intention of modern education



is to train children to have an ability to conceptualise knowledge of the outside world. Thus, probably the preference of the abstract conceptualisation (AC) in learning is rather dependent on learning experience (i.e. how much the person would accept this idea from their teachers) than on own style preference. This postulation may earn support from those findings, which revealed that individuals' preferences for abstract conceptualisation (AC) actually increased with the level of participation in formal education (Kolb, 1976; Kolb & Kolb, 2005). The more education a person receives, more likely s/he prefers abstract conceptualisation (AC) during learning activities.

#### *2.4.2 The Verbal-Imagery Dimension*

The second conceptual dimension of cognitive style is concerned with information representation, which was demonstrated by the VI ratios of the CSA and related to the ACCE scores of LSI. Compared to the WA dimension of cognitive style, the VI dimension has fewer family relatives and hence less literature support for its validity (see Chapter 1). However, the present finding may provide some supportive evidence for it.

The significant negative correlation between the two measures implies the relation of an individual's favoured representation mode (i.e. verbal or imagery) and his/her preference for concrete or abstract material during learning activities. It indicates that 'verbal' people favour the 'thinking' more than the 'feeling' during learning activities. In contrast, 'imagery' people favour the 'feeling' over the 'thinking'. The consistency between the two dimensions was further confirmed by the negative correlation between the VI ratios and AC scores. It suggests that the more frequent individuals represent information verbally, the more theories and ideas they develop during learning (i.e. systematic approaches to problems by abstract conceptualisation). And the positive correlation between the VI ratios and CE scores indicates that the more picture-like representations individuals use, the more likely they learn from ontic concrete experiences.



In brief, people's preferred manner of information representation, language-like or picture-like (Riding, 1991), and their favoured learning stage, feeling or thinking (Kolb, 1984), are conceptually and practically related. It provides extra validity support to Riding's (1997) categorisation on the VI dimension of cognitive style. Although the VI cognitive style and concrete-abstract (ACCE) dimension might not locate on the same layer according to Curry's (1983) Onion Model (see Chapter 1), the concrete-abstract (ACCE) dimension to some extent can be regarded as the projection of the VI cognitive style on the 'information processing' level. The learning style (e.g. the ACCE dimension) is thought to result from the interaction between the fundamental personality/cognitive styles (e.g. the VI cognitive style) and the choices of learning format that are available in the environment. In this case, an individual's preference for handling concrete materials or theoretical concepts reflects the underlying cognitive style of one's preferred representation mode, that is, the VI cognitive style.

In addition, it is interesting to find out that the concrete-abstract (ACCE) dimension did correlate with both the WA and the VI cognitive style ratios, although the latter two did not (see Table 2.2). The finding implies that the two dimensions of cognitive style may respectively explain partial variance of the concrete-abstract (ACCE) dimension. In other words, one's preference for concrete experience or abstract conceptualisation during learning activities may be rooted at both (which locate in an inner layer of the 'onion'; Curry, 1983) cognitive style dimensions. It more or less supports the 'adaptation' postulation that claimed by Riding and Rayner (1998) between the WA and the VI cognitive style (see discussion in Subsection 1.2.1 in Chapter 1). Albeit the two cognitive styles are independent with one or the other as the underlying mechanism, they are possibly correlated at an outer layer of the onion at an information processing level (Curry, 1983).

### *2.4.3 The Reflective-Active Dimension*

The third conceptual dimension in the present study concerned the reflective-active (AERO) dimension of LSI. It decides whether individuals obtain information actively, through the interaction including external involvement to the environment or other people, or reflectively, via solo internal processes. The independence of this dimension has been shown by the non-significant correlation between the dimension scores (including its primary scores AE and RO) with all related measures in the WA and VI dimensions. It can be proposed that this dimension, which relates to the way a person transforms experience externally or internally, has not been conceptually covered by Riding and Cheema's (1991) categorisations. In addition, this reflective-active dimension is suggested to be similar to the description of introversion-extroversion dimension of cognitive style (Jung, 1970; Myers & Briggs, 1985). Introversion refers to an attitude to form ideas and make decisions in isolation. Extroversion points to an orientation toward the outside world where people build their ideas through their interaction with it. Thus, both of them probably reflect a third dimension in the cognitive style research besides the ones concerned with organisation and representation of information. Leonard et al. (1999) supported this idea by providing a positive correlation between the dimensions.

However, the VI cognitive style failed to exhibit a relationship with this learning style dimension. Riding and Dyer (1980) reported a negative correlation between the VI cognitive style and the introversion-extroversion cognitive style and purported that one's preferred coding mode may influence his/her focus of behaviours. This suggestion is not supported by the results. It is argued that the lack of relationship between the VI cognitive style and the reflective-active (AERO) dimension concerns the subject of focus.

Verbalisers were suggested to be more externally focused (Riding & Rayner, 1998). It is because the language nature of their preferred representation mode encourages them to



communicate with others. Communication requires other humans but not objects. Thus, verbalisers are suggested to be socially rather than generally externally focused.

Notwithstanding, the reflective-active (AERO) dimension of Kolb's (1985) learning theory refers to an attitude towards a general outside world. Differentiated subjects of focus might be the reason. This issue will be discussed more in Chapter 5.

#### *2.4.4 Independence between the WA and VI Dimensions and Independence between the ACCE and AERO Dimensions*

The findings also supported the predictions that the WA and VI dimensions of cognitive style are distinct from each other, and the concrete-abstract (ACCE) and the active-reflective (AERO) dimension of learning style are irrelevant from one another.

These are consistent with previous studies (e.g. Riding & Agrell, 1997; Riding & Caine, 1993; Riding & Douglas, 1993; Riding & Pearson, 1994; Riding & Read, 1996) about the independence between the WA and VI dimension of cognitive style, and with those previous findings of the independence between the two learning style dimensions (Boyatzis & Mainemelis, 2000; Freedman & Stumpf, 1978; Kolb, 1999).

## **2.5 Conclusions**

This chapter provides further support for the construct validity of the WA and the VI dimensions of cognitive style. The two style dimensions were reported to be good representatives of the style dimension of either the tendency of information organisation or the preference of representation. The WA cognitive style did correlate with its family relative, the FDI cognitive style, as predicted, but only to a moderate degree. This is explained in terms of confounding factors (e.g. non-style elements, ceiling effect) relating to the GEFT, which reduce the common variance (style-related variance) shared with the WA style. The WA and the VI cognitive styles both contribute to the concrete-abstract

(ACCE) dimension of learning but are independent of each other. It is suggested to reflect not only the respective 'projection' of the two cognitive style dimensions but also the 'adaptation' between them at a information processing level although their underlying mechanisms keep them distinct. The reflective-active (AERO) dimension is identified as a distinct dimension that is independent from the other two cognitive style dimensions (WA and VI). Finally, the discussion of the interrelationships between the individual difference constructs, either related or not, can facilitate the understanding of the nature of the WA and VI cognitive styles.



### **CHAPTER 3. WHOLIST-ANALYTIC STYLE AND ATTENTIONAL CONTROL**

The WA dimension of cognitive style is supposed to reflect how a person views information. Previous findings (including the one stated in Chapter 2) have clearly demonstrated both the validity and reliability of this cognitive style dimension. Hence in this thesis the author's emphasis on the WA cognitive style dimension is moved from the construct validity to its possible impact on varied cognitive processes (in comparison with the VI cognitive style dimension, see Chapter 6). The intention of these behavioural investigations is to facilitate the understanding of the underlying mechanism of this cognitive style dimension as well as its applications into daily life. This chapter aims to determine the particular effect of the WA cognitive style on the attentional control process.

Attentional control refers to the ability to function under distracting or ambiguous conditions and distinguish relevant or irrelevant information (Bialystok, 1986). Based on previous studies, it is proposed that there is a shared variance between the attentional control performance and the WA cognitive style. To examine this postulation, two studies are reported in Chapter 3. A metalinguistic task (in English language), which requires varied levels of attentional control in different conditions, demonstrated differed performances by wholist and analytic individuals in a group of Chinese participants who speak English as a second language (Experiment 1). Analytics exhibited significantly better performance in a high-attentional-control-required condition than the wholists. The finding further confirmed the assertion of the common mechanism existing between the WA cognitive style and attentional control process. In comparison the native English speakers tested with exactly the same task (Experiment 2) failed to show such a difference in performance with regard to the WA style. It was argued that the differentiation between findings of the second language speakers and of native speakers was due to the level of

language proficiency between the two samples. The high language proficiency of native speakers either reduced the effort requirement for attentional control in the task or had developed matured attentional control skills to cover the impact of a built-in WA cognitive style.

More detailed descriptions of studies are as below.

### **3.1 General Introduction**

Within the area of research on the relationship between WA style and language acquisitions (of either first or second language), analytics (FIs) were considered to perform better than wholists (FDs); however, this difference is more prevalent in the earlier stage of language acquisitions (see Tinajero & Paramo, 1998). Many authors (e.g. Abraham, 1983; Bialystok, 1992; Buriel, 1978; Cosan & Beaulieu, 1984; Roszkowski & Snelbecker, 1987; Satterly, 1976) suggested that this FI superiority relied on the enhanced perceptual disembedding and/or restructuring ability, which is demanded by some specific language skills (e.g. application of linguistic rules, identifying discrete linguistic units within larger ones, and detection of irregularities, etc.). However, a major criticism of these studies could be the simplicity of the methodologies used. Most of these studies have simply focused on the relationship between the WA style (FDI style) and school achievement of language, and have not distinguished between measuring linguistic ability and linguistic knowledge. This may reduce the validity of the findings.

Bialystok (1986) proposed that children's linguistic proficiency is based on two components of language processing, namely, the analysis of linguistic knowledge and the control of attentional processing. The analysis of linguistic knowledge involves transferring internal mental representations into explicit linguistic applications. The control of attentional processing requires selectively attending to different aspects/representations



in a real-time linguistic task; the later component, as suggested by Bialystok (1992) is possibly a more general cognitive process functioning across disparate domains. The “control of attentional processing”, is believed to reflect the ability of attentional control.

Here the hypothesis is that the WA style shares overlapped mechanisms with attentional control functioning. According to the earlier descriptions, the WA style reflects a level of perceptual disembedding ability, which appears to entail an ability of attentional control. That is, the ability to function under distracting or ambiguous conditions and distinguish relevant or irrelevant information (“control of attentional processing” as defined by Bialystok, 1986). This function is consistent with the definition of analytics, who tend to analyse the information into discrete parts and have less difficulty in separating a part from the whole context. Thus, the present perspective is that analytic people would show higher abilities of attentional control, and in the present study it is investigated in the context of solving metalinguistic problems.

Traditionally, the paradigm of attentional control studies involves metalinguistic problems where competing information from different aspects is presented and the recipient has to focus on only one aspect (Bowey, 1988; Lundberg, 1978). For example, Bialystok (1992) presented 7-9 year old children with grammatically correct/incorrect and meaningfully correct/incorrect sentences and asked them to judge whether the grammars of the sentences were correct. Some of the sentences were grammatically correct but meaningfully silly; for example, ‘The sun was shining so I opened the chair’. This provided participants with two potentially confusing sources of information – grammar and meaning – and a need to solve the problem by only focusing on grammatical correctness and ignoring the sentence meaning (attentional control). Bialystok found that children’s performances on the attentional-control tasks positively correlated with their scores on FDI cognitive style, which supports the relationship between WA cognitive style

and attentional control ability in metalinguistic processing.

However, although Bialystok's (1986; 1992) theory successfully distinguished two component processes of language, her findings were still limited by only studying children and not adults. If the WA style shares the mechanism with individuals' attentional control in linguistic processing, does it remain even when they are adults? Does this individual characteristic function in a similar way in people's first and second language processing? Or in other words, how would it function when speakers exhibit various linguistic proficiencies?

In the two studies reported in this chapter, a linguistic correction task was used with adults. Participants were given a timed, metalinguistic task and asked to correct grammatical and spelling errors in a set of English texts. The texts were manipulated to be either semantically correct or absurd. It was deduced that the semantically absurd texts would require more attentional control in linguistic processing to reach a given performance because participants needed to avoid paying attention to the 'distraction' from the meanings. Experiment 1 investigated adult second language speakers while Experiment 2 surveyed adult native speakers. The comparison of the two studies intends to display the effect of language proficiency on the hypothesised relationship between the WA style and the attentional control process.

### **3.2 Experiment 1: An investigation of second language speakers**

#### ***3.2.1 Introduction/Hypothesis***

A group of Chinese overseas students who use English as their second language was tested in Experiment 1. This experiment was conducted first because second language speakers have a mutual feature with children in language practice that they are both at a relatively earlier stage of language acquisition. Thus a congruent finding of the



relationship between the WA cognitive style and the attentional control process is expected as Bialystok found (1992).

It is hypothesised that when English is processed as a second language, analytic participants will show better attentional control performance in the metalinguistic task than the wholists. Operationally, analytic people will be less 'distracted' by semantic absurdity and perform more linguistic corrections than the wholists in meaningless contexts. Moreover, analytic participants are expected to show better performance (i.e. more sensitive to anomalies) than the wholists even in normal contexts, as they are also advantageous at some linguistic skills other than the attentional control ability (see Tinajero & Paramo, 1998). If this is found to be the case, it would have implications for both understanding the nature of WA cognitive style, and its application in people's language processing.

### *3.2.2 Method*

#### *3.2.2.1 Design*

A 'between-subjects' design with WA cognitive style as a group variable (wholist versus analytic) was employed. The dependent variables were percentage of errors that participants successfully corrected in the four task conditions (named GM/Gm/SM/Sm, and described in detail in the Subsection 3.2.2.3).

#### *3.2.2.2 Participants*

Forty overseas participants took part in this experiment. Their native language was Chinese and English was their second language. The Chinese sample comprised 18 males and 22 females, with an age range from 20 to 38 years (mean 24.40 years, SD 3.69 years). All participants were registered at the University of Bristol, either as students or visiting researchers. They all self-reported as fluent English speakers and received financial reward for participation.

In addition, prior to the formal testing, extra 10 participants (five males, five females) with the same selection criteria were tested in a pilot study. Their age range was from 17 to 44 years (mean 27 years, SD 7.70 years).

3.2.2.3 Materials

*Linguistic correction.* The identification of errors in a text or judgements of grammatical correctness is widely used in assessing metalinguistic abilities. It requires participants to detect and correct a number of grammatical and morphological mistakes in a particular text.

The material for the correction task was obtained from an online database of College English Test Band 6 (CET-6) in China (2005). CET-6 is a standard English level examination for Chinese college students and is administrated by the Ministry of Education of China. The author chose this database because the material was of a medium level of difficulty and appropriate for normal participants.

Initially, eight English texts were selected. The lengths and difficulties (indicated by readability scores, which base their ratings on the average number of syllables per word and words per sentence) were carefully matched (see Table 3.1). The content of these texts was taken from a widespread list of topics in order to eliminate the influence of the participants' own knowledge.

Table 3.1  
*Statistics of the eight original texts used in the study*

| Text  | 1 <sup>1</sup> | 2 <sup>1</sup> | 3    | 4    | 5    | 6    | 7    | 8    |
|---|----------------|----------------|------|------|------|------|------|------|
| Length (words)                                | 191            | 225            | 195  | 202  | 237  | 188  | 220  | 229  |
| Flesch Reading Ease Score <sup>2</sup>        | 54.5           | 65.1           | 53.0 | 27.0 | 32.1 | 50.1 | 46.5 | 30.5 |
| Flesch-Kincaid Grade Level Score <sup>3</sup> | 11.5           | 7.4            | 10.2 | 12.0 | 12.0 | 11.4 | 11.7 | 12.0 |

*Note<sup>1</sup>:* Text 1 and 2 were used in the pilot study only.  
*Note<sup>2</sup>:* Flesch Reading Ease scores are rated on a 100-point scale and the higher the scores are, the easier the texts are to understand. Most standard texts have Flesch Reading Ease scores of approximately 60 to 70.  
*Note<sup>3</sup>:* Flesch-Kincaid Grade Level Scores are rated on USA grade-school level, so the higher scores are, the harder the texts are to understand. Most standard texts have Flesch-Kincaid Grade Level Scores approximately 7.0 to 8.0.



Each text contained eight spelling mistakes and 12 grammatical mistakes (in two texts there are one more or less of the number of mistakes according to their contents). All spelling mistakes were the ones that people might make in daily life, for example, *commitee* [committee], *champtions* [champions], *commertial* [commercial], *specefied* [specified], *captial* [capital], *unconsciously* [unconsciously], etc. However, the spelling mistakes were designed so that there would be only one correct answer, and if participants detected the wrong word, they should then know the correct word. This was confirmed from the pilot study. The grammatical errors were produced according to the most common rules such as:

1. subject-verb agreement (e.g. “....., the Cannes Film Festival *remain*[remains] an essential showcase for international .....” “..... and photographers *meets*[meet] regular to value .....” “You may *noticed*[have noticed] how people who live or work closely.....”);

2. correct comparative forms (e.g. “The *importantest*[most important] provision of the agreement is .....” “....., Real Madrid became the *most great*[greatest] club ever, .....”);

3. appropriate tense (e.g. “Work *begins*[began] on the current stadium in October 1944.” “Early audits showed that minorities *are*[were] pictured far too infrequently and .....”);

4. active or passive voice (e.g. “..... to form a partnership *knows*[is known] as an article of .....” “..... is imitated by an *admired*[admiring] fan; .....”);

5. definite articles (“..... in *resort city*[the resort city] of Cannes, .....” “..... gave CBS its reputation as *quality news broadcaster*[a quality news broadcaster].”);

6. plurality (“....., CBS *were*[was] organised in 1928 .....” “..... Francois Truffaut addressed *these issue* [this issue/these issues] in 1956 when .....”); etc.

In order to generate the semantically absurd condition of each text, a few nouns and verbs in each text were changed in order to make it meaningfully distracting; however, it was still possible to complete the task. For example, “On July 13<sup>th</sup>, 1931, it *begins*[began] *expreimental*[experimental] microwave broadcasting in New York, and ten years late began regular Jack and Rose weekly broadcasts over WTOS station in the same city, .....”. In this case, although the sentence is meaningless, participants would be able to detect and correct the grammatical target into the past tense according to either the time point (“1931”) or the later verb’s (the second “began”) morphology.

In total, 16 texts were created from the eight original ones (two example texts were placed in Appendix B with one in a meaningful context and the other in a meaningless context). Four of them were used in a pilot study in order to decide an appropriate difficulty of the task (i.e. how long a participant is allowed to spend on each text). The other 12 texts were used for the main experiment.

Participants were randomly divided into two groups. In the pilot study, participants in Group A were tested by the meaningful version of text 1 (see Table 3.1) and the meaningless version of text 2, and participants in Group B worked through the other two texts. Similarly, in the main experiment, participants in Group A worked on texts 3, 4, 5 with the meaningful version and texts 6, 7, 8 with the meaningless version; while, participants in Group B worked with texts 3, 4, 5 with meaningless version and texts 6, 7, 8 with the meaningful versions (see Table 3.1). As a result, each participant was exposed to both the meaningful and meaningless context conditions, and experienced all the original texts in a counterbalanced order.

Each participant performed four types of task: finding grammatical errors in a meaningful context (GM), finding grammatical errors in a meaningless context (Gm), finding spelling mistakes in a meaningful context (SM), and finding spelling mistakes in a



meaningless context (Sm). These four item types measured different aspects of linguistic processing. GM and SM were baseline measures and arguably needed little attentional control as the contexts were supportive and had no source of information to 'distract'. Thus, they were simple indications of participants' capabilities to analyse the linguistic anomalies. However, Gm and Sm are more relevant to attentional control processing because participants have to ignore the competing and irrelevant information from the meaning, and focus on linguistic forms only. So participants' performances on the later two tasks are suggested to reflect their attentional control abilities/skills.

*WA Cognitive Style.* Participants were assessed by CSA (Riding, 2005) to determine their WA cognitive style ratios.

#### *3.2.2.4 Procedure*

A pilot study was conducted first to decide the timing of the task. The result showed that 4 minutes per text was a suitable time limit for second language speakers so that they were able to go through a text of approximately 200 words but not find all the mistakes (i.e. ceiling effects were avoided).

Experiments took place individually in a quiet room. Participants all did the linguistic correction tasks first. They were randomly assigned into two groups, A and B. In the main experiment, the sequence of six texts (either meaningful or meaningless) was presented in a different random order for each individual. Participants were instructed to correct as many as possible mistakes (both grammatical and spelling) contained in each text in 4 min irrespective of meaningfulness. Then participants finished the experiment with the completion of the CSA test, and were thanked and debriefed.

#### *3.2.2.5 Data Analysis*

An independent t-test was employed prior to formal analyses to check the possible gender difference on the WA cognitive style ratios. (The VI cognitive style ratios were

also checked for gender differences. None were found,  $p > .05$ ). The result suggested that gender was not a confounding factor for the present sample ( $p > .05$ ) and it would not be considered in the following analyses.

### 3.2.3 Results

Means and standard deviations of the WA cognitive style ratios and task performances are reported in Table 3.2. Two paired sample t-tests were conducted to determine if the context (meaning) would affect participants' performances on grammatical and spelling corrections. Results revealed that neither the performance of grammatical error corrections ( $t(39) = 0.104, p > .05$ ) nor the performance of spelling mistake corrections ( $t(39) = 0.019, p > .05$ ) were affected by context meaningfulness in the present experiment.

Table 3.2  
Means and standard deviations of participants' WA cognitive style ratios and performances<sup>1</sup> (in %)

|      | WA ratios | Grammar |    | Spelling |    |
|------|-----------|---------|----|----------|----|
|      |           | M       | m  | M        | m  |
| Mean | 1.37      | 31      | 31 | 24       | 24 |
| SD   | 0.40      | 14      | 13 | 16       | 15 |

Note. <sup>1</sup> = the percentage of the errors in the texts that participants corrected under each condition; Grammar = grammatical errors; Spelling = spelling mistakes; M = meaningful context; m = semantic absurd context.

In order to make an operational comparison between 'wholists' and 'analytics', participants were divided into two similar size groups based on the median (1.34) of WA ratios (e.g. Riding & Agrell, 1997). Wholists had WA ratios from 0.76 to 1.34, and analytics from 1.35 to 2.77. The paired sample t-tests were re-employed within either the wholist or analytic group, and found that participants' performances on grammatical and spelling corrections were still unaffected by the context (meaning) (both  $p > .05$ ).

The mean scores were reported separately for each condition with the results of ANOVAs to determine if the difference between the WA style groups was significant (see



Table 3.3). Four one-way unrelated sample ANOVAs were conducted on participants' scores in each experimental condition (GM/Gm/SM/Sm); they showed that the analytics did correct more grammatical errors than the wholists in the meaningless context (Gm,  $p < .05$ ), but such a difference failed to reach significance in the normal context (GM,  $p = .07$ ). The effect size analysis ( $\eta_p^2$ ) showed that the WA cognitive style difference accounted for about 11% of variance in the dependent variable Gm and about 9% of variance in the dependent variable GM. No significant differences were found on spelling performances (both  $p > .05$ ).

Table 3.3  
*Means and standard deviations (in brackets) of participants' performances (%) of WA style groups with ANOVA results*

|                 | Grammar |         | Spelling |         |
|-----------------|---------|---------|----------|---------|
|                 | M       | m       | M        | m       |
| Wholist (N=21)  | 28 [12] | 27 [13] | 23 [17]  | 22 [14] |
| Analytic (N=19) | 36 [15] | 36 [13] | 25 [15]  | 26 [17] |
| F               | 3.61    | 4.77    | 0.19     | 0.73    |
| $p$             | .07     | .04*    | .66      | .40     |
| $\eta_p^2$      | .09     | .11     | .01      | .02     |

*Note.* Grammar = grammatical errors; Spelling = spelling mistakes; M = meaningful context; m = semantic absurd context.

In order to confirm further the relationship between the dependent variables and the WA cognitive style continuum, the sample was divided into three groups (13 wholists, 14 intermediates, 13 analytics) based on their WA ratios (Riding, 2005) and the intermediate group was then discarded. The hypothesis is that the larger ‘distance’ between the style groups would positively enhance the differences of performances on the tasks. Thus, two new ‘en-distanced’ WA cognitive style groups were created; a new wholist group containing ratios from 0.76 to 1.12, and a new analytic group containing ratios from 1.52 to 2.77.

As predicted, the differences were enhanced on grammatical tasks with a larger distance between the two new style groups. Using Gm as the dependent variable, which is

more relevant to the attentional ability, the difference remained significant ( $p = .01$ ) and the WA style accounted for the double variance compared to before (23%). Using GM as the dependent variable, which is more relevant to linguistic analysis, the difference became significant ( $p < .05$ ) and the WA style also accounted for more variance (16%). These results further supported the hypothesis that more analytic people have better attentional control ability. The differences on the performances of spelling tasks remained minor and non-significant ( $p > .05$ ) (as shown in Table 3.4).

Table 3.4

*Means and standard deviations (in brackets) of participants' performances (%) of en-distanced WA style groups with ANOVA results*

|                 | Grammar |         | Spelling |         |
|-----------------|---------|---------|----------|---------|
|                 | M       | m       | M        | m       |
| Wholist (N=13)  | 26 [12] | 25 [13] | 21 [13]  | 22 [13] |
| Analytic (N=13) | 38 [15] | 38 [11] | 25 [15]  | 26 [13] |
| F               | 4.62    | 7.31    | 0.53     | 0.39    |
| <i>p</i>        | .04*    | .01*    | .47      | .54     |
| $\eta_p^2$      | .16     | .23     | .02      | .02     |

*Note.* Grammar = grammatical errors; Spelling = spelling mistakes; M = meaningful context; m = semantic absurd context.

### 3.2.4 Discussion

The results reveal a strong effect that analytic people are superior to wholist people when they solve high-attention-control metalinguistic problems (Gm); this finding supported the hypothesis. Analytic individuals, who are characterised by higher disembedding ability, benefit in an environment that requires attention to be focused on one particular aspect when salient information from competing and irrelevant aspects is present. Analytic participants were more able to concentrate on the task (e.g. correcting the grammatical errors) whilst ignoring the distracting absurdity from the contextual meaning. Wholist participants performed worse because their characteristic is to organise the input information as a whole, and hence they are more vulnerable to the distraction from structure related information, even when irrelevant to their purpose. As they are more



affected by the distraction of contextual meaning, their performance was lower than the analytic participants. In addition, the larger the 'distance' between the WA style groups, the greater the difference between their performances on the high-attention-control metalinguistic task (Gm). It seems that the 'distance' on the WA style dimension positively reflects the difference of attentional control ability. This finding is consistent with Bialystok's (1992) conclusion that children's attentional control solution to specific metalinguistic problems shared a significant portion of the variance with FDI style (WA dimension). This is not just limited to children, but also includes adults, who are at an earlier stage of a language acquisition. The interesting question is whether this would be the case for adults at a later stage of language acquisition. (This question will be addressed in Experiment 2.)

Moreover, in the en-distanced style groups, analytic participants also performed significantly better than wholists in the GM task, which is argued to be a pure indication of participants' analysis of linguistic knowledge (detecting and correcting grammatical errors in normal contexts). In other words, the WA style groups did account for a certain amount of variance in the analysis of linguistic knowledge. This finding is also consistent with previous studies that the WA dimension of cognitive style may have positive effects on language acquisition (see, Tinajero & Paramo, 1998). And because of the relatively narrow linguistic application tested in the present experiment (i.e. concerned only with grammar acceptability rather than the overall achievement of language that actually reflects a number of specific abilities) the result may further support the theory that the greater perceptual disembedding/restructuring ability of analytic people (FIs) favours the learning and application of linguistic rules (Abraham, 1983; Chapelle & Green, 1992).

In addition, it was initially supposed that the Sm task would imply selective attention towards vocabularies, and simultaneously, the ignoring of meaning. However, the

WA style seemed to have no effect on spelling corrections in either normal or semantic absurd context (SM/Sm). The non-significant effect of WA cognitive style may result from that the task is too easy to be automated. Thus, the possible difficulties due to the low attentional control ability could be quickly overcome as the two aspects of the problem, spelling and context meaning, are not very closely connected.

Further, there was an interesting finding that for these overseas Chinese students, the context meaningfulness would not influence their performance. This is surprising given a subsequent finding reported in this issue (see Experiment 2) that native English speakers' linguistic performances were heavily (and naturally) affected by the context meaningfulness. The consideration of a biased sampling can be ruled out, because a non-difference between the meaningful and meaningless conditions not only existed across the whole sample, but also was found within each cognitive style group (i.e. wholist or analytic). If the null effect of context meaningfulness on participants' performance was caused by an overall 'analytic' sample, for example, the effect of context meaningfulness should have been found in the wholist group. Therefore, it is something beyond style itself.

Feedback from participants suggested that they were consciously ignoring the meaning when solving the problem. For example, some of the participants could not even recall the topics of the texts after the testing. This is probably due to the specific skills those participants applied during the test. Tasks conducted in the present experiment were originally revised from an exercise of English language examination in China. The students must have been taught and trained to apply an attentional control skill (e.g. 'Work on grammars and ignore the meanings!') to solve the problem, as it is efficient to earn marks in a limited time. This suggests the difference between attentional control ability and skill. On one hand, the attentional control ability could be an in-built characteristic like cognitive style. On the other hand, the attentional control skill could be intentionally



developed as a result of training/instruction. This issue will be covered with more details in the next section.

In conclusion, the findings of the present experiment align with the suggestion that the aptitude of analytic individuals not only favours the solution that requires a high ability of attentional control, but also the linguistic application of grammatical rules in second language processing. Interestingly, the participants also showed the use of an attentional control skill during the task, which suggests a distinction is necessary between attentional control *ability* and the attentional control *skill*. The last issue will be further emphasised in discussion of Experiment 2.

### **3.3 Experiment 2: The follow-up investigation of native speakers**

#### **3.3.1 Introduction /Hypothesis**

Experiment 1 has showed a significant main effect of the WA cognitive style on the attentional control task (i.e. Gm) in second language processing. The analytic participants performed more corrections than wholist ones in a distracting meaning context. This result suggested that analytic people were less ‘distracted’ by semantic absurdity than wholists in their second language processing. Combining with Bialystok’s (1992) finding, both results provide support to the hypothesis that there is a relationship between WA cognitive style and attentional control ability. However, previous research has merely focused on children of a young age (Bialystok, 1992) and second language speakers, that is, both at a relatively earlier stage of language acquisition, and this leaves the question of whether the findings can be applied in later stages of language acquisition, specifically, for native adult speakers. The present experiment was conducted to further clarify this issue.

#### **3.3.2 Method**

##### **3.3.2.1 Design**

The present experiment remained a 'between-subjects' design with WA cognitive style as a group variable (wholist versus analytic). The dependent variables were percentage of errors that participants successfully corrected in the four task conditions (GM/Gm/SM/Sm, identical with Experiment 1).

### *3.3.2.2 Participants*

Forty-two native English speakers (28 females, 14 males) participated in this experiment. Their ages ranged from 15 to 26 years (mean 19 years, SD 1.48 years). All participants were registered on undergraduate psychology courses, and received course credit for participation (except one female participant who was a work experience student aged 15, and who attended the experiment voluntarily).

In addition, prior to the formal testing, further 10 native English participants (five females, five males) were tested in a pilot study. All participants of the pilot study were postgraduate students or staff at the university. They took part in the experiment voluntarily. Their age range was from 17 to 44 years (mean 27 years, SD 7.70 years).

### *3.3.2.3 Materials*

*Linguistic correction.* The present experiment employed the same linguistic correction task with Experiment 1 that manipulated the relative degree to which the attentional control processing is implicated in each text.

*WA Cognitive Style.* Participants took the CSA (Riding, 2005) to describe their profiles of WA cognitive style.

### *3.3.2.4 Procedure*

A pilot study was conducted first to decide the timing of the task. The result of this showed that 2 min per text was a suitable time limit for native speakers, in which they were able to work through a text of approximately 200 words but be unable to find all the mistakes (compared to the 4 min per text for Chinese participants in Experiment 1).



The procedures of the linguistic correction task were identical with Experiment 1 except that participants had 2 min instead of 4 min to work on each text. After the metalinguistic task, participants completed the CSA test, and were then thanked and debriefed.

### 3.3.2.5 Data Analysis

An independent t-test did not reveal any significant gender difference on the WA cognitive style ratios in the present sample ( $p > .05$ ). Also, no significant gender difference was found on the VI cognitive style ratios,  $p > .05$ .

### 3.3.3 Results

Table 3.5  
*Means and standard deviations of participants' WA cognitive style ratios and task performances (%)*

|      | WA ratios | Grammar |    | Spelling |    |
|------|-----------|---------|----|----------|----|
|      |           | M       | m  | M        | m  |
| Mean | 1.05      | 46      | 33 | 40       | 35 |
| SD   | 0.20      | 12      | 12 | 16       | 16 |

*Note.* M = meaningful context; m = semantically absurd context.

Participants' performances were recorded as percentages of errors that were successfully corrected under each task condition (GM/Gm/SM/Sm). Table 3.5 reports means and standard deviations of participants' WA cognitive style ratios and their task performances. Two paired sample t-tests were employed to determine if the context (meaning) would affect participants' performances of grammatical and spelling correction. The results revealed that more grammatical errors were corrected in the meaningful texts than in the semantically absurd texts,  $t(41) = 5.47, p < .01$ , as well as spelling mistakes,  $t(41) = 3.32, p < .01$ . This suggested that the meaning of context did affect native participants' performances in the linguistic correction tasks (in contrast with second language participants in Experiment 1).

In order to make an operational comparison between 'wholist' and 'analytic'

participants, the sample was divided into two equal size groups based on the median (1.025) of WA ratios (see, Riding & Agrell, 1997). The divisions were: wholists 0.61 to 1.02, analytics 1.03 to 1.67.

Four one-way ANOVAs on participants' scores in each experimental condition (GM/Gm/SM/Sm) showed no main effect of WA style group ( $p > .05$ ). See Table 3.6.

Table 3.6

*Means and standard deviations (in parentheses) of performances (%) of WA style groups*

|                 | Grammar |         | Spelling |         |
|-----------------|---------|---------|----------|---------|
|                 | M       | m       | M        | m       |
| Wholist (n=21)  | 47 [12] | 37 [12] | 40 [16]  | 36 [16] |
| Analytic (n=21) | 46 [11] | 31 [12] | 39 [16]  | 33 [16] |
| F               | .047    | 2.052   | 0.111    | 0.637   |
| $p$             | .830    | .160    | .741     | .430    |
| $\eta_p^2$      | .001    | .049    | .003     | .016    |

Note. M = meaningful context; m = semantically absurd context.

Table 3.7

*Means and standard deviations (in parentheses) of performances (%) of en-distanced WA style groups*

|                 | Grammar |         | Spelling |         |
|-----------------|---------|---------|----------|---------|
|                 | M       | m       | M        | m       |
| Wholist (n=14)  | 46 [13] | 38 [9]  | 43 [16]  | 38 [15] |
| Analytic (n=14) | 44 [11] | 33 [12] | 36 [10]  | 30 [12] |
| F               | .242    | 1.402   | 1.588    | 2.183   |
| $p$             | .627    | .247    | .219     | .152    |
| $\eta_p^2$      | .009    | .051    | .058     | .077    |

Note. M = meaningful context; m = semantically absurd context.

Imitating Experiment 1, the sample was divided into three equal groups (14 wholists, 14 intermediates, 14 analytics) based on their WA ratios, and the middle group (intermediates) was then discarded (Riding, 2005). As a result, a new wholist group containing ratios from 0.61 to 0.94, and a new analytic group with ratios from 1.13 to 1.67 were constructed.

Four more one-way ANOVAs were employed on the new en-distanced sample (n=28). The results showed that the new WA style groups had no significant effects on the



performances (GM/Gm/SM/Sm) either. See Table 3.7.

### 3.3.4 Discussion

The main aim of the present chapter was to consider the role of attentional control in metalinguistic problems in relation to WA cognitive style. Experiment 1 supported the hypothesis that analytic people were ‘distracted’ by semantic absurdity to a significantly *lesser* degree and showed better attentional control ability than wholists in second language processing.

Bialystok (1992) also reported that children’s solutions to specific metalinguistic problems (requiring high levels of control of attention) shared a significant portion of the variance with FDI style (WA style). These previous results supported the idea that attentional control ability features the WA cognitive style. It is likely that the way in which an individual tends to organise information (wholist or analytic) would relate to his/her attentional control performance.

However, as results showed in Experiment 2, in contrast to second language speakers and children, native adult English speakers did not perform differently on the metalinguistic tasks according to their WA cognitive style. This also applied when only the individuals at the extremes of the wholist and analytic scales were considered, which decreased the possibility that the non-significant difference between the WA style groups was caused by the insufficient ‘distance’ between the wholist and analytic style groups.

It is worth noting that the present sample of native speakers had a relatively restricted range of the WA ratios ( $1.05 \pm 0.20$ ) compared to the second language speaker sample in Experiment 1 ( $1.37 \pm 0.40$ ). The WA ratio distribution of the present sample ( $1.05 \pm 0.20$ ) was also more “wholist” than Riding’s (2005) original standardised sample ( $1.25 \pm 0.45$ ;  $n = 999$ ). However, the data was much closer to a recent sample (Riding, 2005) which comprised of 2131 school pupils, aged 12 to 16 years, with 1056 males and

1075 females ( $1.10 \pm 0.44$ ). The possible inconsistency between the present sample and the standardised sample might narrow down the application of the finding (i.e. the *very* analytic people, with WA ratio  $> 1.65$ , might be still able to show better performance in attentional control tasks than the *very* wholist people, with WA ratio  $< 0.65$ , who hardly featured in the sample of Experiment 2). However, the conclusion can be drawn (albeit cautiously) that for most people with moderate cognitive styles, their performances of attentional control in metalinguistic tasks were irrelevant in terms of their WA cognitive style in their native language. In addition, all participants' mean metalinguistic performance scores ranged from 30-50%; thus, ceiling and floor effects were not an influence here.

There are three possible theoretical interpretations for these results.

First, the hypothesis is a null assumption that neither the solution to metalinguistic tasks nor the WA cognitive style is relevant to attentional control ability. This explanation is relatively unlikely as a previous series of experiments has adequately established the mechanism of attentional control in metalinguistic processing and connected it to WA cognitive style (Bialystok, 1988a; 1988b; 1992; Experiment 1 of the chapter).

The second interpretation is that the result relates to different levels of participants' proficiency of language in the experiments. Adult native speakers have considerable superiority to both second language speakers and children in linguistic application. For them, language processing has become over-learned and automatic; thus, it requires less attentional effort. Jackendoff (1987) found that compared to low-skilled performers, high-skilled performers paid less attention, but needed the same level of detail and explicit representations (knowledge) to achieve a given level of performance. It could be deduced that because of adult native participants' significantly high proficiency in using the English language, their metalinguistic processing no longer relies on attentional control ability to



any prominent degree. Therefore their WA cognitive style will not affect the performances in the attention control tasks (i.e. Gm, Sm). This interpretation is consistent with the earlier claim on FDI cognitive style (e.g. Davey & Menke, 1990; Davis, 1991) that the effect of FDI on children's reading abilities gradually lessens when those abilities become more automatic. However, young children and average second language speakers, who are relatively 'low-skilled performers', still need extra effort to control their attention in metalinguistic processing (i.e. switching focus between distinct aspects of input) and their WA cognitive style will have a significant effect.

A third interpretation is that attentional control processing in native language can evolve as a domain-specific skill and separate from the WA cognitive style, which remains a domain-general individual characteristic. At an earlier stage of language acquisition, attentional control ability works as a domain-general individual characteristic (which is related to WA cognitive style) and can be applied to language practice resulting in diverse performances. However, after a certain level of experience, an analogous but nurtured domain-specific attentional control skill is developed to aid linguistic processing, while WA cognitive style remains unchanged throughout the time. This could explain why young children and second language speakers' metalinguistic performances are affected by their WA cognitive style. They have not yet developed mature attentional control skills to compensate the limitations of their own attentional control abilities in contrast to native adult speakers.

The idea of nurtured attentional control skill is indirectly supported by several studies of bilingual children, who were found to have enhanced attentional control skills in metalinguistic tasks but undifferentiated knowledge of literacy compared to monolingual children (e.g. Edward & Christophersen, 1988; Galambos & Goldin-Meadow, 1990). The same age children showed a similar level of literacy, but the bilingual children

demonstrated better skills of attentional control because they had more experience of changing their focus of attention between two languages. Bialystok (1992) also suggested that different attentional control strategies were developed and applied by children with a low level and a high level of language proficiency (e.g. varied years of training and experience). Although she did not explicitly include second language speakers into her theory, the logical similarity is obvious.

In sum, children and second language speakers, who have less experience of certain language practice, are still relying on their innate attentional control ability (relating to WA cognitive style). However, experienced native speakers, who have developed their attentional control skills and have had plenty of language practice in daily life, are much less affected by the fixed WA cognitive style/attentional control ability.

In conclusion, although in children and second language speakers, analytics showed better attentional control performance that were more robust to distracting information in the metalinguistic task than wholists; native adult speakers failed to show the same tendency. This difference can be explained in two ways: 1) different levels of attentional effort are required in language processing according to the level of language proficiency; 2) there is a distinction between attentional control ability as a built-in individual characteristic (relating to WA cognitive style) and attentional control skill as a domain-specific strategy (which can be nurtured with language practice). For native speakers, who have become proficient in their language, certain attentional control skills have been developed to compensate the limitation of their innate attentional control abilities (reflecting in the WA cognitive style). The latter interpretation may have academic implications. The distinction between style and skill needs to be taken into consideration in future cognitive style research and the mechanism underlying it needs to be explored further. On one hand, the results would suggest that although style might be fixed, people's



learning activities are changeable, which enable them to improve their performance. For example, perhaps wholist people have a natural disadvantage in certain metalinguistic tasks; however, by developing specific skills through practice, they approach the same level of performance as analytic people, who were naturally superior at the beginning.

On the other hand, this finding could highlight possible confusion between style and skill. Currently, there is much debate about the research of styles, such as, the validity of the measurements, their stability, even the existence of styles etc. But researchers should not lose sight of the most fundamental issue: what are styles? Perhaps they have been confused with human nurtured skills. The clarification of the two concepts could be critical regardless of whether researchers' final aim is to understand styles, or to apply them to educational environments. A review of style and skill, their distinction and relationship, could be especially important for all researchers working in this area.

### 3.4 Conclusions

This chapter investigates the relationship between the WA cognitive style and attentional control. Results from two metalinguistic experiments, which surveyed both second language speakers and native English speakers, suggested that the analytic individuals appeared a significant superiority in the attentional control process at an earlier but not a later stage of language acquisition (second language speakers versus native speakers). It is argued that the WA cognitive style, as a domain-general individual characteristic, does share a certain amount of variance with the attentional control process. However, during the development of language proficiency, the influence of WA cognitive style in the metalinguistic performance is likely to be 'overwritten' by either the reduced requirement of attentional effort or the appearance of substitutable attentional control skills. The finding may have implication on the future research of style.

In short, this chapter has illustrated how the WA cognitive style might affect an individual's selection of information from language input. It is suggested that analytics demonstrate an advantage over wholists by specifically targeting only relevant information. Then naturally, the next question of interest is how would they utilize the information perceived? The next chapter will continually emphasise the impact of the WA cognitive style on the perception of social information by the agency of stereotype formation.



## **CHAPTER 4. THE WHOLIST-ANALYTIC STYLE AND STEREOTYPE FORMATION**

In conjunction with Chapter 3, this chapter maintains the emphasis on the WA cognitive style, and will investigate its impact on the stereotype formation of social individuals (based on presented descriptions). Stereotype was suggested to be a product of the strategy to represent social information efficiently. Hence, it is rational to hypothesise that a relationship exists between the way a person prefers to organise information (the WA cognitive style) and his/her stereotypic representations of social information. By addressing such a relationship, further clarification of the mechanism and application of this dimension of cognitive style will be made. The findings in this chapter revealed that wholists and analytics did manifest diverse aptitude in organising stereotypic information. The intermediates, who were newly introduced in the present chapter and were characterised with the features of both wholist and analytic, resulted in the best performance of memory.

### **4.1 Introduction**

The social environment around us is complex to the extent that it is not possible to process information without some manner of simplification (see Fiske & Neuberg, 1990; Lippman, 1922). Accordingly, the stereotype is one of the tools that help to reduce the cognitive load of social information. Stereotypes have been suggested as being energy-saving mental devices for efficient analysis of the complex social environment to which people are exposed (see Allport, 1954; Brewer, 1988; Fiske & Neuberg, 1990; Higgins & Bargh, 1987; Lippman, 1922; Macrae, Milne, & Bodenhausen, 1994; Sherman, Judd, & Park, 1989 etc.). It is easy to understand that in a certain social situation, for example,

when meeting a stranger, it is necessary to evaluate the person in order to hold an impression of him/her. There could be two ways to perform the evaluation. One is individuation by mentally representing every person individually. This is effort consuming (Brewer, 1988; Fiske & Neuberg, 1990; Fiske & Pavelchak, 1986). The other way is stereotyping that involves mentally assigning individuals into socially meaningful categories and generalising the knowledge of the categories (i.e. stereotypic knowledge) to the understanding of individuals. That is, linking the individuals' information to pre-existing knowledge frameworks. In this way, people are able to represent the social environment in a cognitively economical manner (Hamilton, 1979; Hamilton, Sherman, & Ruvolo, 1990; Hamilton & Trolie, 1986). Thus, stereotyping is a popular theme in social psychology research in both revealing the mechanisms underlying human adaptation to the environment and considering the implication of this type of behaviour (e.g. as in a court case).

Interestingly, if the use of a stereotype could be regarded as a consequence of the strategy that people use to organise better information of others (e.g. Crawford & Skowronski, 1998), it is logical to assume there is a relationship between stereotyping and people's inherent tendency in the way they organise information, namely, the WA cognitive style. Hence, the present study will employ stereotype as an agency to investigate the impact of the WA cognitive style on information categorisation.

This study employs the paradigm of Macrae et al. (1994). In their stereotype study, they presented participants with lists of trait words describing hypothetical targets. Some of the trait words of each list were consistent with a stereotype label (e.g. 'caring' is consistent with the stereotypic beliefs of 'doctor') and others were neutral (e.g. 'unlucky' has nothing particular to do with the stereotypic beliefs of 'doctor'). Participants were required to use these word lists to form an impression of each target. Finally, they were



asked to complete an unexpected written recall of those trait words.

In the paradigm, the between-subject manipulation was whether participants were presented with the explicit stereotype labels (e.g. 'doctor'). Hence, there were four stereotypic conditions of the stimuli in the study: (A) stereotype-consistent traits with stereotype label presence; (B) stereotype-neutral traits with stereotype label presence; (C) stereotype-consistent traits with stereotype label absence; (D) stereotype-neutral traits with stereotype label absence. The theory behind such a paradigm is that the stereotype labels provoke accessible mental frameworks, on which participants are able to organise information with ease (especially stereotype-consistent ones); while with the absence of the stereotype labels, the accessing of such frameworks becomes difficult and results in compromising the memory of the information (Macrae et al., 1994).

Condition A involves the least difficulty because the presence of the stereotype labels provides explicit themes relating to pre-existed knowledge frameworks (e.g. the stereotype category 'doctor'). Condition B is probably more difficult and effortful compared to Condition A. In this condition, although explicit stereotype labels are presented (e.g. 'doctor'), the stimulus materials (e.g. 'unlucky') are not originally associated with the provoked frameworks. Therefore, in order to form the impressions of the targets (as required by the instruction) participants strive to reconcile the incongruent information into the stereotypic categories. Conditions C and D are without the presence of stereotype labels; thus there are no available explicit clues for the relevant mental frameworks and organisations. However, there is evidence to suggest that in such theme-absent situations, individuals may sometimes spontaneously strive for the structure of organisation (Tulving, 1962). Hence, in Condition C individuals are still possible to access the potential mental frameworks but not in Condition D.

In the study of Macrae et al. (1994) and others that employed the same paradigm

(e.g. Crawford & Skowronski, 1998), strong stereotype biases in recall have been reported. Findings included: more trait words were remembered when the stereotype labels were explicitly presented than when labels were absent; more stereotype-consistent trait words were remembered than stereotype-neutral ones; and the explicit presentation of the stereotype labels especially facilitated the memory of those stereotype-consistent trait words.

The present study examines how the way people tend to organise information, either in a whole or analytically, might affect the stereotype biases. The WA cognitive style groups are hypothesised to demonstrate different performances with respect to the four stereotypic conditions, which will be discussed as below. Note that, here the term ‘wholist’ and ‘analytic’ only refer to the relative tendency along the dimension of WA cognitive style. Further discussion of the grouping will be covered in Section 4.2.

In Condition A, the presence of the stereotype labels can import meaning to the stereotype consistent stimulus materials and could be served as organisation themes (Bransford & Johnson, 1972). In such supportive circumstances wholist individuals probably have advantage to hold holistic structures of the materials and accordingly connect to the relevant pre-existing frameworks. Thus their performance of the recall could be enhanced.

Condition B is rather complex compared to Condition A. Although there are stereotype labels provided, the stimulus materials do not semantically relate. Thus, participants have to reconcile the discrepant information with the provoked stereotype beliefs. That is, they have to apply the mental models (e.g. pre-existing beliefs) upon those originally unrelated materials, which is necessarily effortful. Douglas and Riding (1993) reported that wholist individuals were less able to impose mental organisation on unstructured materials when no integrating cue was provided. However, with the help of



explicit themes (e.g. stereotype labels), wholist individuals can manage to result in comparable performance with analytic individuals. Thus no performance difference is expected between wholist and analytic participants in Condition B.

In Condition C the stereotype labels are not presented, but the stimulus materials are stereotype consistent, and therefore related to each other. Here, wholists who have a better natural overview of information are more likely to gain the implicit structure of stimuli compared to analytics. On the other hand, analytic participants who tend to view information as collections of units are probably not motivated to construct the information into organised structures. But they are able to show relatively good memory of discrete words even without facilitation of associated organisations (Burton & Sinatra, 1984). Consequently, analytic participants may demonstrate equivalent recall performance with their wholist peers. No performance difference is expected between wholist and analytic participants in Condition C.

Condition D, which is different from all other conditions, has no facilitation of explicit organising themes or associated knowledge frameworks. Participants' performance in this condition is simply the incidental memory of lists of discrete trait words. Wholist individuals might be disadvantageous here as they have difficulty in perceiving and organising discriminate units (e.g. Burton & Sinatra, 1984; Douglas & Riding, 1993).

Overall, individuals may exhibit different trends of the stereotype bias with respect to their WA cognitive styles as they would interact with stereotypic conditions in varied ways. Wholist individuals are predicted to exhibit a more "dependent" trend in their performance. Their performances are likely to be influenced by the presence of explicit stereotype themes and the stereotype-relatedness of the materials and will therefore be sensitive to each experimental condition. In contrast, analytic individuals, who can be regarded equivalent to 'field-independents', are expected to have a more "independent"

trend in their performance. In this experiment the presence of stereotype labels is a between-subject factor, while every participant will be exposed to both stereotype-related and unrelated materials. In this case, analytic individuals could be less influenced by the relatedness of stimuli because they prefer to persist in their strategy of organisation (probably triggered by the presence/absence of the labels) and ignore the changes in material congruence. For example, analytic participants might regard all stimulus words (no matter whether they are stereotype-consistent or neutral) as discrete units when the stereotype labels are not present.

Accordingly, a short list of hypotheses is stated below. H1-H2 describe the possible differences caused by the WA cognitive style on the stereotypic conditions. H3 reflects the hypothesised impact holistic and analytical aptitude might have on overall stereotype bias trend.

H1. Wholist participants will show better recall performance than analytics in Condition A (stereotype-consistent traits with stereotype label present).

H2. Wholist participants will show poorer recall performance than analytic participants in Condition D (stereotype-neutral traits with stereotype label absent).

H3. Overall, wholist participants will show a more “dependent” trend in performance according stereotypic conditions; while analytic participants will show a more “independent” trend.

## **4.2 Method**

### ***4.2.1 Design***

The study was a  $3 \times 2 \times 2$  mixed design with the WA style (wholists, intermediates, and analytics) and the presence of stereotype labels (present versus absent) as between-subject factors, and the trait type (stereotype-consistent versus stereotype-neutral) as the



within-subject factor. The dependent variable was the number of traits participants recalled at the end of the experiment.

#### 4.2.2 Participants

Sixty-six participants (54 females, 12 males) took part in the study. Gender was not considered as a confounding factor in stereotypic studies (Crawford & Skowronski, 1998; Macrae et al., 1994). Thereby, the high portion of females in the present sample was argued acceptable.

They had an average age of 19.5 years with SD 3.17 years (range from 15 to 40 years). All were registered in undergraduate psychology courses and received course credit for doing the study except two female participants who were work experience students aged 15 and attended the study voluntarily. All participants reported being native or fluent English speakers.

#### 4.2.3 Materials

Table 4.1  
*Stereotype labels and personality traits for impression formation task*

| <i>Nigel (doctor)</i> | <i>Julian (artist)</i> | <i>John (skinhead)</i> | <i>Graham (estate agent)</i> |
|-----------------------|------------------------|------------------------|------------------------------|
| Caring                | <b>Creative</b>        | <b>Rebellious</b>      | <b>Pushy</b>                 |
| Honest                | <b>Temperamental</b>   | <b>Aggressive</b>      | <b>Talkative</b>             |
| Reliable              | <b>Unconventional</b>  | <b>Dishonest</b>       | <b>Arrogant</b>              |
| Upstanding            | <b>Sensitive</b>       | <b>Untrustworthy</b>   | <b>Confident</b>             |
| Responsible           | <b>Individualistic</b> | <b>Dangerous</b>       | <b>Unscrupulous</b>          |
| Unlucky               | Fearless               | Lucky                  | Musical                      |
| Forgetful             | Active                 | Observant              | Pessimistic                  |
| Passive               | Cordial                | Modest                 | Humourless                   |
| Clumsy                | Progressive            | Optimistic             | Alert                        |
| Enthusiastic          | Generous               | Curious                | Spirited                     |

*Note.* Stereotype-consistent words are in bold type.

Table 4.1 shows the targets and the descriptive personality traits used in the experiment. These stimuli were identical to those used in Macrae et al. (1994). Five in ten descriptive traits of each target are stereotype consistent with respect to the stereotype

label provided and five are neutral. Macrae et al. have conducted a pilot study to require participants to rate the extent to which a large number of traits were characteristic of a range of social categories. The consistency of the traits with each stereotypic target was then determined.

In the present study, a DMDX programme (Forster & Forster, 2003) was employed to display the stimuli. Four blocks of the programme were produced with one target for each block. Each time a trait appeared (e.g. aggressive), it was displayed beside the target name (e.g. John) for 3000 ms (as in Crawford & Skowronski, 1998). To control for any possible primacy and recency effects in recall, the 10 describing traits in each block were randomised by the programme prior to each session and the order of presentation of the four blocks (target names) were counterbalanced within either stereotype label condition but matched between the two conditions. That is, Participant A in the stereotype-label-present condition received the targets in the Graham – John – Julian – Nigel sequence, while Participant B in the stereotype-label-absent condition received the same sequence. In this way, the stimuli displayed in the two experimental conditions were identical except for the stereotype label presence.

The CSA (Riding, 2005) was used to collect the profiles of WA cognitive style of the participants.

#### *4.2.4 Procedure*

Participants arrived at the laboratory individually, and were randomly assigned into either the stereotype-label-present or the stereotype-label-absent condition. The participants were told that in the study, information of four individuals would be presented in the form of descriptive traits and they were required to use these traits to form impressions of the targets.

Then, participants were seated facing a computer screen about 60 cm away. Each



trial began with a blank mask on the screen for 1000 ms and the stimuli were presented at the centre of the screen in font Arial, size 66 for 3000 ms with the target name at the left hand side and the trait descriptor at right hand side (e.g. “John Aggressive”). In addition, half of participants were also given a stereotype label with the target name (e.g. “John-skinhead Aggressive”).

Following the paced presentation of stereotype trials, participants completed the CSA (Riding, 2005) to determine their position on the WA dimension continuum. There were 16 participants who had been tested by CSA in the author’s previous studies and instead they completed the 12-item Learning Style Inventory (LSI) developed by Kolb and Kolb (2005). Those data of the questionnaire was not included in the present study and rather provided a filled delay between the trait presentation and the trait recall.

Finally, participants were required to perform an unexpected recall task of the traits with which they had been presented. They were given a sheet of paper with four target names on the top and were asked to write down as many of the originally matched traits under each name as possible (see Appendix C). Each participant had 10 min to complete the task. The dependent measure was the number of traits correctly recalled and attributed to the appropriate target. After the recall task, participants were thanked and debriefed.

#### *4.2.5 Data Analysis*

A one-way ANOVA was conducted to determine whether participants that were assigned to the two label-presence conditions (i.e. stereotype label present versus stereotype label absent) differed in WA cognitive style ratios. The results revealed that the WA style ratios were well matched across the between-subject condition ( $p > .05$ ).

### **4.3 Results**

*Cognitive style groups.* Being consistent with Riding’s (2005) division, participants



were partitioned into three similar sized groups on this cognitive style dimension.

Participants whose ratios were below 1.00 were grouped into the 'wholist' group ( $n = 22$ ), participants whose ratios were between 1.00 and 1.26 were grouped into 'intermediate' group ( $n = 21$ ), and those whose ratios were beyond 1.26 were grouped into the 'analytic' group ( $n = 23$ ).

The 'intermediates' were separately grouped for the first time in this thesis to allow the new type of analysis. As an operational definition of this style group, intermediate individuals are those who respond to wholist and analytic questions (see Chapter 1) almost equally fast in the CSA test (Riding, 2005). Thus, they have the equivalent proficiency to view information holistically or analytically.

*Recall performance.* The numbers of stereotype-consistent and stereotype-neutral traits correctly recalled and attributed to the appropriate targets were recorded for each participant. Figure 4.1 presented the means of the number of recalled traits as functions of trait type and label presence condition in WA groups.

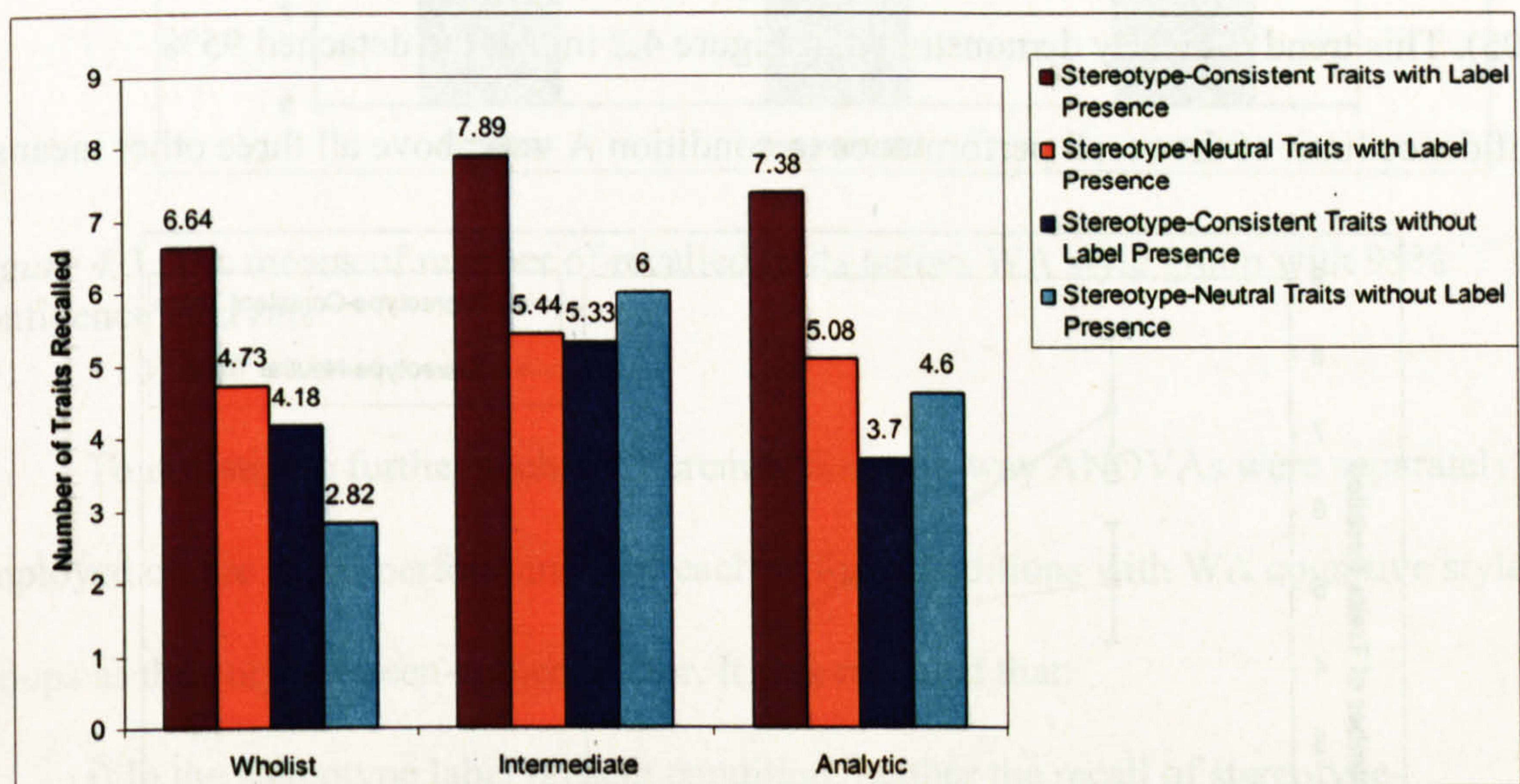


Figure 4.1. Number of traits recalled as a function of stereotype label presence, trait type, and WA cognitive style groups

A three factors mixed ANOVA was employed with WA cognitive style group (wholist, intermediate, and analytic) and label presence (with versus without) as between



subject factors and trait type (stereotype-consistent versus stereotype-neutral) as a within-subject factor, on the number of traits that participants correctly recalled in the study. As predicted, participants recalled a greater number of traits in the stereotype-label-present condition (mean = 6.19) than the stereotype-label-absent condition (mean = 4.44),  $F(1, 60) = 12.36, p < .01, \eta_p^2 = 0.17$ . Also there was a congruity bias in that a greater number of stereotype-consistent traits (mean = 5.85) was recalled than of stereotype-neutral traits (mean = 4.78),  $F(1, 60) = 9.35, p < .01, \eta_p^2 = 0.14$ . Further, a significant label presence  $\times$  trait type interaction was revealed,  $F(1, 60) = 10.56, p < .01, \eta_p^2 = 0.15$ . Post-hoc exploration of the interaction using the Tukey HSD method (MSE = 4.033) showed that (i) the recall performance of stereotype-consistent traits in the label present condition (Condition A) was significantly higher than all other three experimental conditions (Condition B, C, D; all  $p < .01$ ); (ii) trait recall performances were equivalent for stereotype-consistent and stereotype-neutral traits in the label absent condition (Condition C and D) and stereotype-neutral traits in the label present condition (Condition B; all  $p > .05$ ). This trend is clearly demonstrated in Figure 4.2 in that the detached 95% confidence limit of the recall performance in condition A was above all three other means.

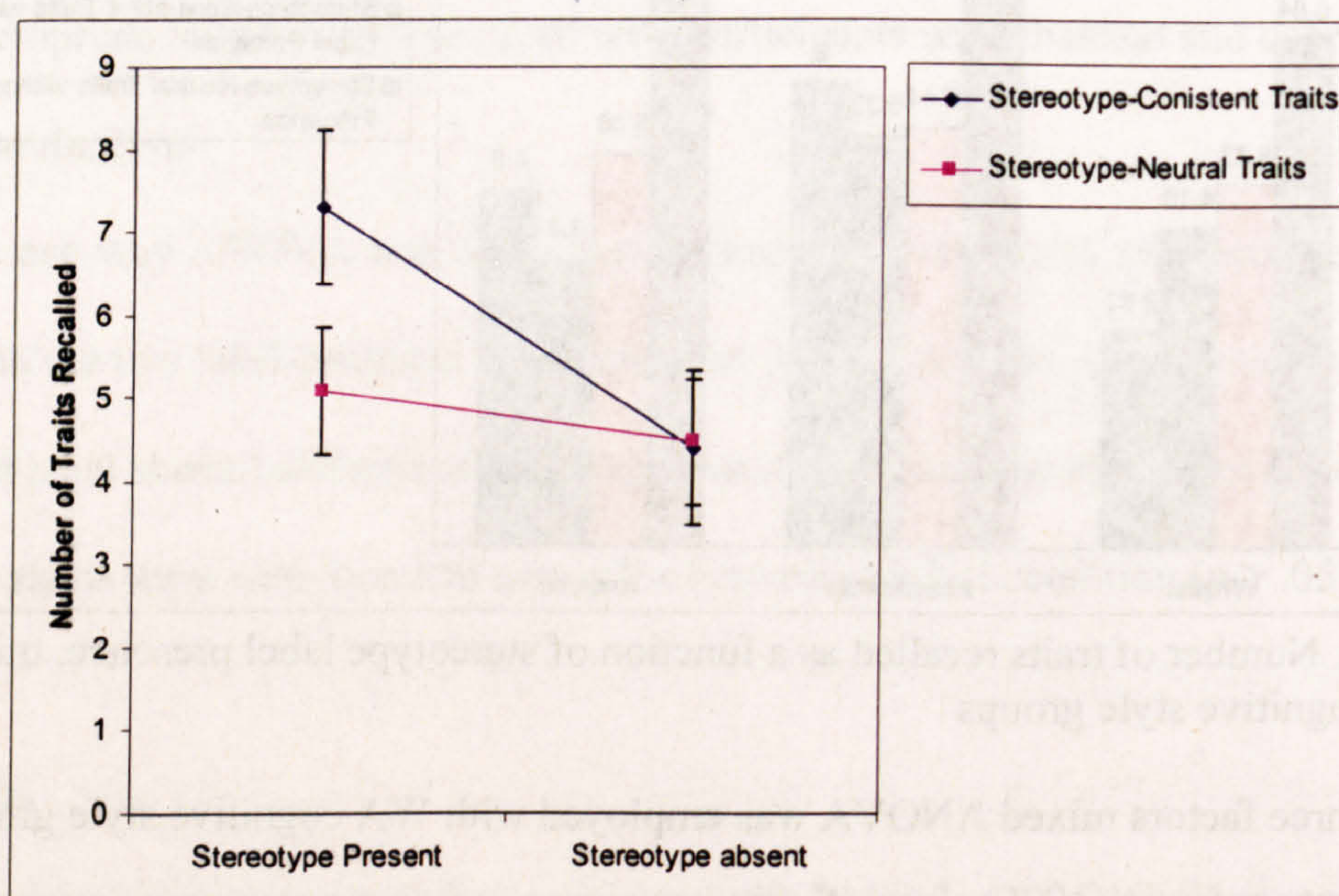
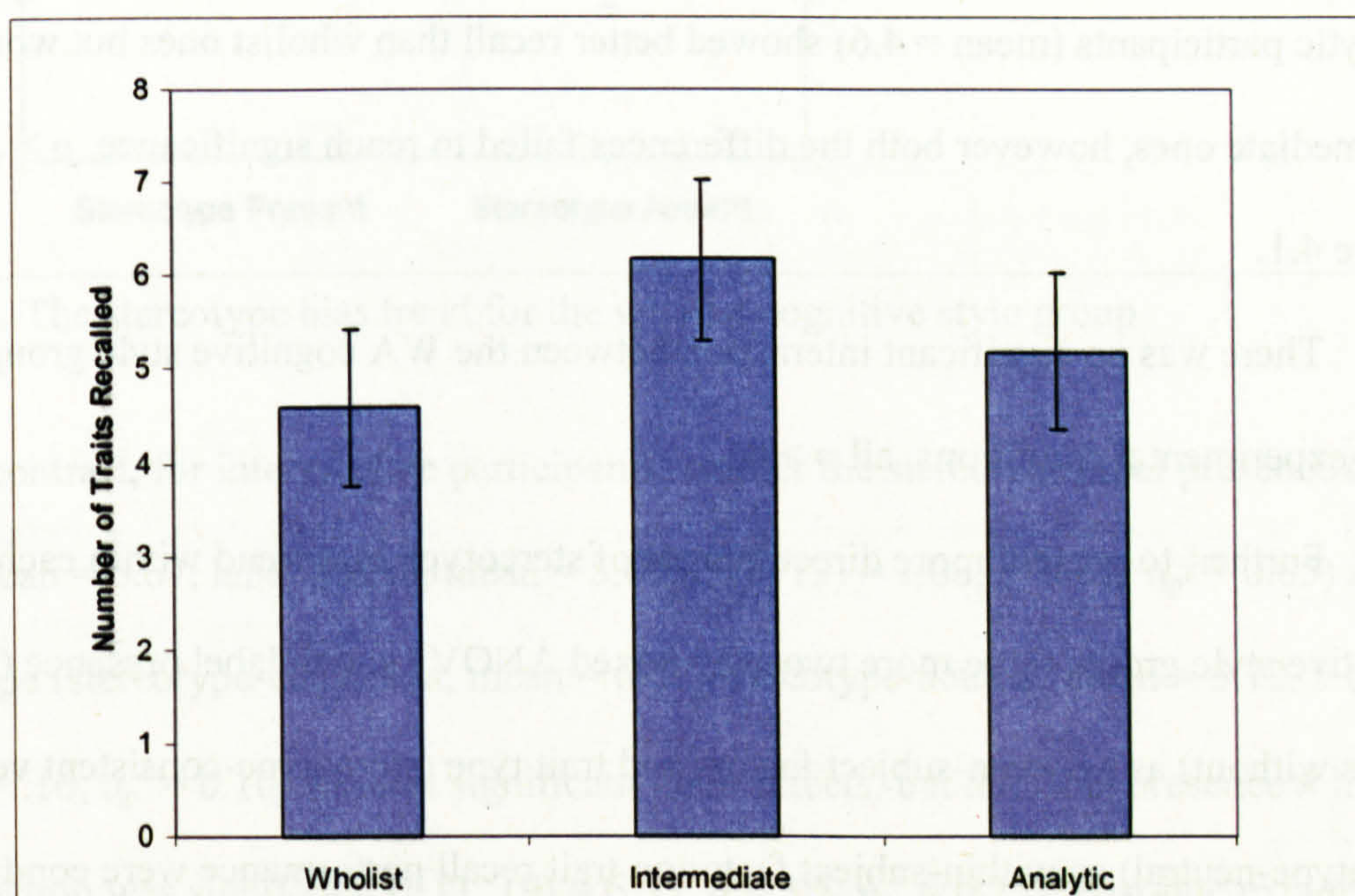


Figure 4.2. The label presence  $\times$  trait type interaction with 95% confidence interval



Additionally, there was also a main effect of WA cognitive style group,  $F(2, 60) = 3.31, p < .05, \eta_p^2 = 0.10$ . A further post hoc test using the Tukey HSD method suggested that wholist participants (mean = 4.59) showed significantly lower recall performance than intermediate participants (mean = 6.17),  $p < .05$ , and close performance to analytic participants (mean = 5.19),  $p > .05$ . Analytic participants recalled slightly less traits than intermediate participants, but the difference did not reach significance,  $p > .05$ . See Figure 4.3.



*Figure 4.3.* The means of number of recalled traits across WA style group with 95% confidence intervals

To investigate further such a difference, four one-way ANOVAs were separately employed on the recall performances of each of four conditions with WA cognitive style groups as the only between-subject factor. It was revealed that:

- i) In the stereotype label present condition, neither the recall of stereotype-consistent traits (Condition A;  $F(2, 30) = 0.54, p > .58, \eta_p^2 = 0.04$ ) nor the recall of stereotype-neutral traits (condition B;  $F(2, 30) = 0.34, p > .71, \eta_p^2 = 0.02$ ) differed within the WA cognitive style groups;



ii) In the stereotype label absent condition, the recall of stereotype-consistent traits (Condition C) was not ( $F(2, 30) = 1.11, p > .34, \eta_p^2 = 0.07$ ) but the recall of stereotype-neutral traits was (Condition D;  $F(2, 30) = 4.85, p < .05, \eta_p^2 = 0.24$ ) affected by the WA cognitive style groups.

The difference of the recall performance in Condition D has repeated the pattern of overall recall performance that wholist participants performed worst (mean = 2.82) in that their recalls were significantly lower than intermediate participants (mean = 6,  $p < .05$ ). Analytic participants (mean = 4.6) showed better recall than wholist ones but worse than intermediate ones, however both the differences failed to reach significance,  $p > .05$ . See Figure 4.1.

There was no significant interaction between the WA cognitive style groups and other experimental conditions, all  $p > .05$ .

Further, to present more direct images of stereotype bias trend within each WA cognitive style group, three more two-way mixed ANOVAs with label presence (with versus without) as between-subject factors and trait type (stereotype-consistent versus stereotype-neutral) as within-subject factor on trait recall performance were conducted for the wholist, intermediate, and analytic groups respectively.

For wholist participants, significant main effects were revealed by the stereotype label presence (label present, mean = 5.68; label absent, mean = 3.50,  $F(1, 20) = 8.04, p = .01, \eta_p^2 = 0.29$ ) and by the trait type (stereotype-consistent, mean = 5.41, stereotype-neutral, mean = 3.77,  $F(1, 20) = 6.57, p < .05, \eta_p^2 = 0.25$ ); however, no significant label presence  $\times$  trait type interaction was found ( $F(1, 20) = 0.18, p > .67, \eta_p^2 = 0.01$ ). See Figure 4.4.



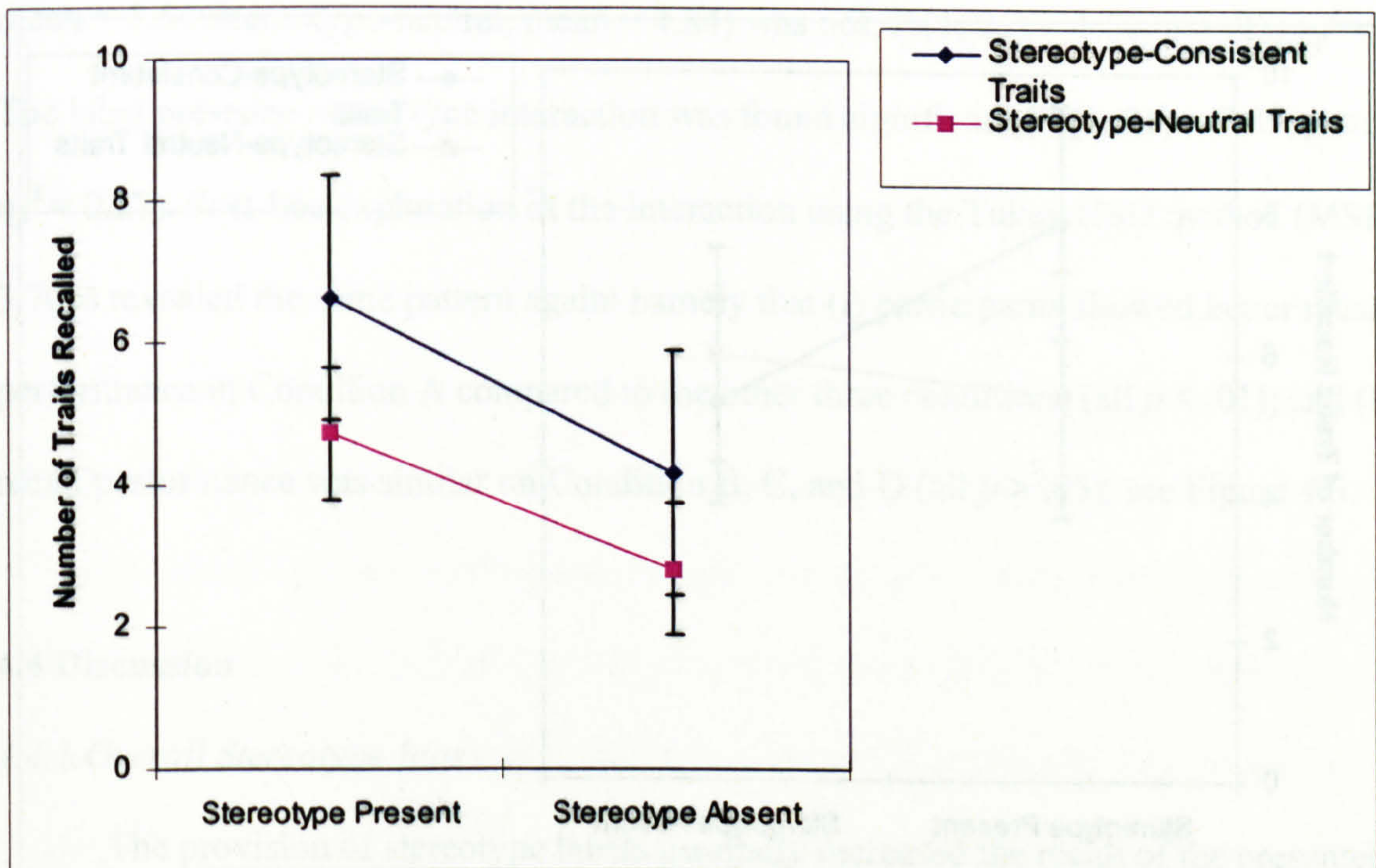


Figure 4.4. The stereotype bias trend for the wholist cognitive style group

In contrast, for intermediate participants, neither the stereotype label presence (label present, mean = 6.67, label absent, mean = 5.67,  $F(1, 19) = 1.08$ ,  $p > .31$ ,  $\eta_p^2 = 0.05$ ) nor the trait type (stereotype-consistent, mean = 6.61, stereotype-neutral, mean = 5.72,  $F(1, 19) = 2.07$ ,  $p > .16$ ,  $\eta_p^2 = 0.10$ ) showed significant main effects, but the label presence  $\times$  trait type interaction was significant ( $F(1, 19) = 6.35$ ,  $p < .05$ ,  $\eta_p^2 = 0.25$ ). Post-hoc exploration of the interaction using the Turkey HSD method ( $MSE = 3.918$ ) showed a consistent trend with the overall label presence  $\times$  trait type interaction (see Figure 4.5) that (i) the recall performance in Condition A was significantly higher than in Condition B ( $p < .01$ ), Condition C ( $p < .01$ ), and Condition D ( $p < .05$ ); (ii) trait recall performances were equivalent in Conditions B, C, and D ( $p > .05$ ).



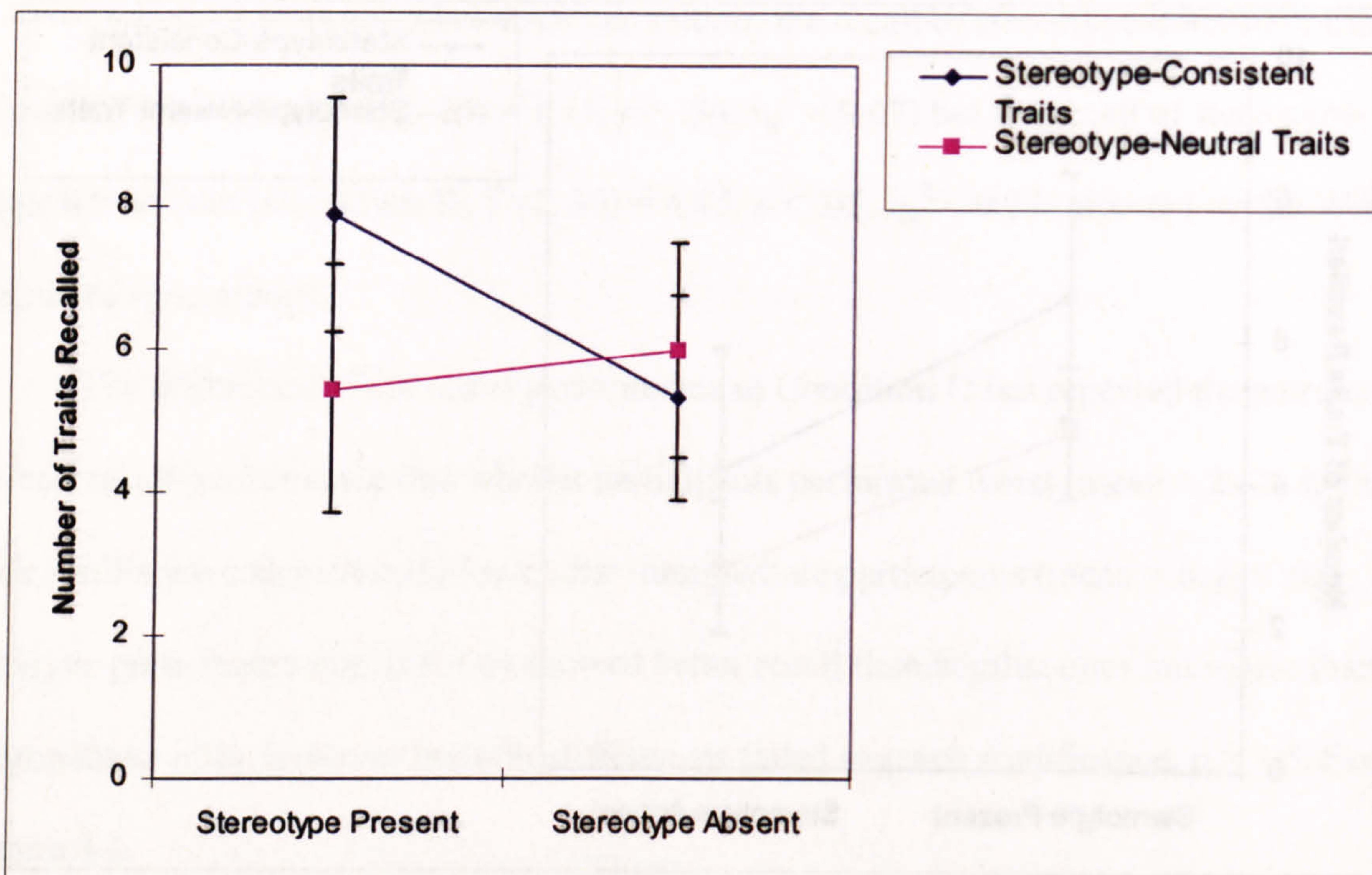


Figure 4.5. The stereotype bias trend for the intermediate cognitive style group

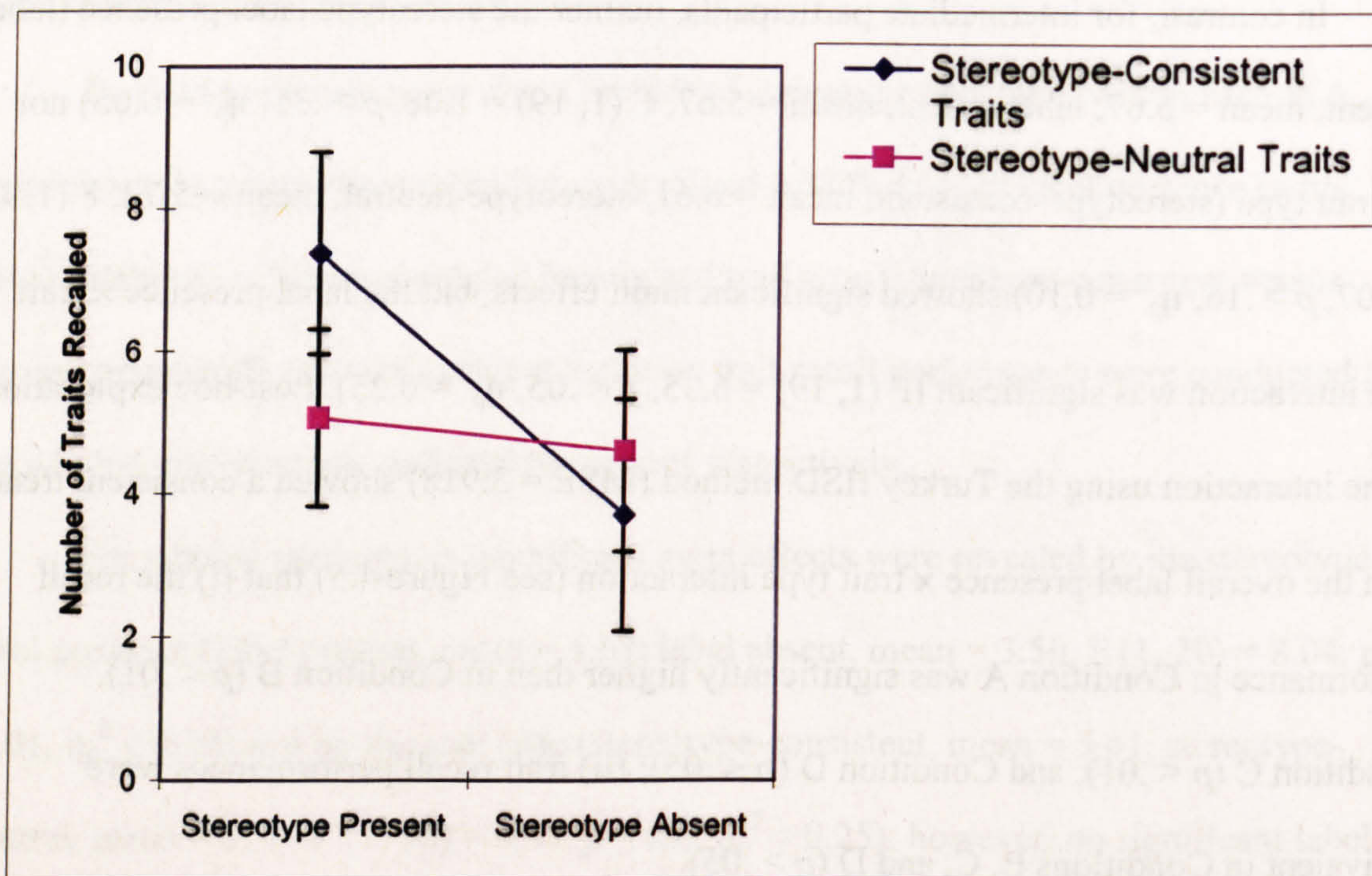


Figure 4.6. The stereotype bias trend for the analytic cognitive style group

For analytic participants, the main effect of stereotype label presence condition (label present, mean = 6.23; label absent, mean = 4.15) was found to be significant,  $F(1, 21) = 5.88, p < .05, \eta_p^2 = 0.22$ , while the main effect of trait type (stereotype-consistent,



mean = 5.54; stereotype-neutral, mean = 4.84) was not,  $F(1, 21) = 1.51, p > .23, \eta_p^2 = 0.07$ . The label presence  $\times$  trait type interaction was found significant ( $F(1, 21) = 7.85, p < .05, \eta_p^2 = 0.27$ ). Post-hoc exploration of the interaction using the Tukey HSD method ( $MSE = 3.706$ ) revealed the same pattern again: namely that (i) participants showed better recall performance in Condition A compared to the other three conditions (all  $p < .01$ ); and (ii) recall performance was similar on Condition B, C, and D (all  $p > .05$ ), see Figure 4.6.

## 4.4 Discussion

### 4.4.1 Overall Stereotype Bias

The provision of stereotype labels generally increased the recall of the presented trait words, with this effect being most pronounced for stereotype-consistent traits. In addition, more stereotype-consistent traits were retrieved overall compared to stereotype-neutral traits. They are consistent with previous findings using the paradigm (e.g. Macrae et al., 1994), which supports the validity of the experimental manipulation.

The stereotype bias in memory could be explained by the accessibility of pre-existing mental frameworks. The presence of the stereotype labels offers cues for accessing the relevant mental knowledge frameworks, which facilitate the memory of categorised representations by simplifying the process of organising and structuring information. When the stereotype labels are absent, however, there will be a lack of such accessible cues to mental frameworks and it will make the memory and recall process more effortful and resource-hungry (Srull & Wyer, 1989). Consequently, recall performance is lower.

Furthermore, the presence of the stereotype labels manipulates the expectancy of the stimuli presented. It has been suggested that expectancy-congruent information should be superiorly encoded in memory compared to expectancy-incongruent information. This



is because of the advantage held by expectancy-congruent information in being assimilated or integrated into an existing knowledge structure (Neisser, 1976; Taylor & Crocker, 1981). Stereotype labels, which can serve as guiding themes, affect expectancies of the presented stimuli (i.e. stereotype-consistent traits are more likely to be expectancy-congruent, while stereotype-neutral traits are probably expectancy-incongruent). In line, the presence of stereotype labels enhances the encoding and representation of stereotype-consistent traits rather than stereotype-neutral traits in long-term memory (Bodenhausen, 1988; Bodenhausen & Wyer, 1985; Macrae, Hewstone, & Griffiths, 1993; Stangor & Duan, 1991). However, the absence of the stereotype labels leads to no expectation of personality traits and accordingly exhibits no difference between the stereotype-consistent traits and the stereotype-neutral traits.

#### *4.4.2 Influence of WA Cognitive Style on Each Stereotypic Condition*

It is of interest to find that wholist participants remember generally less trait words than intermediate and analytic participants. Trying to explain such a difference, further analyses have been introduced into each stereotypic condition. With consideration of the hypotheses, the results will be discussed in turn.

Wholist participants did not exhibit a better recall memory in Condition A (stereotype-consistent traits with stereotype label present) but were equivalent with intermediate and analytic participants. H1 is therefore not supported. It was probably because of too little difficulty and effort required in accomplishing the task and so the advantage of participants' preferred organisation (e.g. a global view) could not be sufficiently reflected in their performance. The overtly presented organising themes and the presumed existence of a semantic relationship between the trait words probably would make the work rather easy and effortless for all participants. So the superiority of the wholists' adept organisation will be concealed by the 'ceiling effect'. Although the

analytic individuals are not as good as wholist ones in viewing spontaneously the stimuli in holistic frameworks, they are still able to represent the materials efficiently. Hence, no difference was found regarding WA style groups in Condition A.

There was no difference in recall performance between the WA cognitive style groups in Condition B (stereotype-neutral traits with stereotype label present), which supported the prediction made in the introduction. In this condition, wholist participants have constructed originally unrelated information into frameworks with the aid of explicit stereotype labels and finally get equivalent performance with analytic and intermediate participants. This result is consistent with Douglas and Riding's (1993) finding.

The WA cognitive style groups remembered equal numbers of stereotype-consistent traits in Condition C (with stereotype label absent), which is again consistent with earlier prediction. In this condition, wholist participants were presumed to construct (by their adept holistic view) implicitly related materials into frameworks though no explicit theme was presented. In contrast, analytics might perceive the trait words without holistic structures. However, their superior memory for unstructured materials has compensated any possible difference caused by organising strategies.

The only difference demonstrated between the WA cognitive style groups was found in Condition D (stereotype-neutral traits with stereotype label absent). H2 was therefore supported. Wholist participants exhibited a compromised memory of discriminate trait words compared to intermediate and analytic ones. Their holistic nature of viewing the world causes difficulties in perceiving discriminate units sufficiently (e.g. Douglas & Riding, 1993). Burton and Sinatra (1984) have found a discrete word recall disadvantage for FD children, which supported this assumption.

#### *4.4.3 Impact of WA Cognitive Style on Overall Stereotype Bias Trend*

Individuals did show different general trends of the stereotype bias with regard to



their WA cognitive style. H3 was supported. For example, wholist participants showed no label presence  $\times$  trait type interaction but a significant main effect of label presence and trait type. Their performance in four stereotypic conditions showed an obvious 'step' shape corresponding to the difficulties of the conditions (see Figure 4.1, 4.4). In other words, the performances of the wholist participants were overtly 'dependent' on experimental conditions. For instance, they structured stimuli with the help of explicit cues of relevant mental frameworks, and/or expectancy congruence of materials respectively, but without an active integrating process. As a result, the facilitation of the cued mental frameworks and the stimuli expectancy congruence were additive, but not integrative.

Analytic participants differed from wholist ones in that they showed a significant label presence  $\times$  trait type interaction and a main effect of stereotype label, but no main effect of trait type. It is consistent with the hypothesis that analytic individuals were more 'determined' about their strategy to organise information and less sensitive to the stimulus materials. The strategy could be chosen according to the given circumstance. For example, the provision of explicit stereotype labels may trigger those analytic participants to organise all information in relation to mental frameworks irrespective of trait type. By this strategy, they generally remembered more trait words than those in the stereotype label absent condition. It is noteworthy that even the neutral trait words were remembered more than the two conditions without label presence (Conditions C and D) (see Figure 4.1). Although the difference was slight, it can somewhat support the postulation of strategy. The stereotype-neutral traits were hard to represent within themed frameworks, however the mental effort participants spent to organise them within frameworks did arguably enhance the memory. On the other hand, the absence of the explicit labels probably led to an unstructure of stimuli and such a strategy was constant for both consistent and neutral traits. It was found that the analytic participants who had not received explicit theme clues

recalled less stereotype-consistent traits than stereotype-neutral ones (see Figure 4.1).

Although the difference was non-significant, its tendency was opposite to any classic trait type effect. The most intuitive interpretation is that they did not stereotype the information at all. In short, analytic participants were more persistent in their strategy of information organisation once it had been decided in the given circumstances, and kept the strategy 'independent' from the stimulus materials.

The intermediate group, which was newly introduced in this chapter, revealed another different trend of stereotype bias. In the experiment, the intermediate participants showed a significant label presence  $\times$  trait type interaction with no main effect of label presence or trait type. This is argued to result from a combined manner of wholist and analytic organisation. Intermediate individuals characterise with the same level of holistic and analytic organising ability (Riding, 2005), and freely select to use either. For those who have seen the stereotype labels, the holistic feature enabled them to be sensitive to the material and only employed the stereotype to think about the stereotype-consistent information during encoding. In contrast, the stereotype-neutral traits were probably represented in an unstructured (analytical) way. While for those without the stereotype labels presented, they were 'material-independent' during the encoding that treated all materials as discrete information. Moreover, the analytic view helped intermediates to perceive unstructured information with ease, which led to an overall better memory compared to wholist participants.

## 4.5 Conclusions

The study revealed a robust stereotype bias in that the stereotypic information was generally easy to remember especially when a stereotype label was explicitly presented. Further, in conjunction with the WA cognitive style, it was found that the information



processing in different stereotypic conditions would be affected by one's favoured organisation aptitude. The wholists depended more on stereotypic conditions during information processing and memorised passively corresponding to the aids (e.g. presence of stereotype label, material consistency, etc.) provided by the situation. The analytics were more independent from the influence of stimulus materials that once they chose the strategy of perception according to experimental settings (i.e. presence of stereotype labels) they would persist with it irrespective of stimulus consistency. The intermediates, who entail both holistic and analytical views of perceiving, selectively used one of the two organisations depending on the task requirement and obtained the best performance in memory of stimuli. Moreover, the study has demonstrated an inability of wholist individuals to organise and memorise irrelevant information.

The next chapter will move on to the issue of how cognitive styles affect the way an individual regards the self.

## **CHAPTER 5. COGNITIVE STYLES AND SELF CONCEPT RELATED BEHAVIOURS**

Chapter 4 discussed the influence of the WA cognitive style on strategies used to deal with information about others. The present chapter aims to relate the WA cognitive style, in conjunction with the VI cognitive style, to another domain of social perception, namely that of the self-related concepts. The study collected data from three aspects. First, a couple of tasks concerning the embodiment and dis embodiment processes of the self were devised, in which both revealed a main effect of the WA cognitive style, with wholists showing superiority on both tasks. It was concluded that the WA cognitive style (applying global or analytical organisation) influences the integrated bodily self representing process. Secondly, empathy scores of participants were reported, which is assumed to reflect an ability of emotional dis embodiment, and an imager advantage was found. Therefore, the VI cognitive style arguably affects the comprehension and intuitive response of others' mental states (empathy) by individuals' adept coding manners. Finally, participants' attachment styles, which were suggested to relate to self- or other- oriented attentions, were investigated. The VI cognitive style was found interacting with gender on attachment anxiety. Being inclined to the verbal representation might consequently reinforce the attachment anxiety (which probably links to other-oriented attention of social behaviours), but only for women. In sum, the WA and the VI cognitive styles are suggested to be connected to self-related concepts, nevertheless in different aspects.

### **5.1 Introduction**

As the previous chapter showed the impact of cognitive style on processing others (though only the WA cognitive style was found relevant so far), it is sensible to transfer



the focus to the other side of social perception; the concept of self. Will the cognitive styles, which decide the way we may process information, also affect how we perceive ourselves and how we separate ourselves from others? To investigate this issue, the present study employed both behavioural and self-report measures to reflect different aspects of self-non-self processes. The embodiment/disembodiment tasks (Subsection 5.1.1) examine the representation of spatial self and self-disembodiment, while the empathy questionnaire (Subsection 5.1.2) reflects the aptitude of an emotional disembodiment. In addition, subsection 5.1.3 introduces attachment styles as index of self-oriented or other-oriented social attentions. With all these measures, the particular relationship between the cognitive styles and the self-related processes might be determined and shed light on the understanding of cognitive styles. The introduction first starts with the representation of spatial self.

#### *5.1.1 Embodiment and Disembodiment of the Self*

The sense of self is a very special concept during processing therefore it has crucial implications of understanding human consciousness. Numerous studies have distinguished specific brain mechanisms for the self and body processing (Blanke et al., 2005; Blanke, Landis, Spinelli, & Seeck, 2004; Jeannerod, 2003; Metzinger, 2003) from all other mental executions. It has been in particular favour in recent neuropsychological research whereby plenty of findings have linked the self process to diverse physiological basis. This subsection will emphasise the evidence of the representation of spatial self.

The sense of self can be reflected in two contrasting processes, namely, the embodiment and the disembodiment process. Embodiment involves mentally localising oneself within his/her own body borders while disembodiment refers to localising the self out of the body (Arzy, Thut, Mohr, Michel, & Blanke, 2006). Two specialised tasks were employed to demonstrate the two processes by taking each in turn.

### *Disembodiment/Egocentric Perspective Taking*

The disembodiment process of the self was found particularly associated with the cortex at the right temporoparietal junction (TPJ) responding to localise the self out of the body (Arzy et al., 2006; Blanke, Ortigue, Landis, & Seeck, 2002; Blanke et al., 2004; 2005; Zacks, Rypma, Gabrieli, Tversky, & Glover, 1999). It often includes imagining the self at an extracorporeal position (outside the embodied position). In the present study, this self disembodiment process will be represented by an egocentric perspective transformation task.

Egocentric perspective transformation refers to mentally transferring oneself into another person's position and imagining what they would be able to see (Zacks et al., 1999). It is an essential activity in one's day-to-day life, especially as it is an element of many human social interactions, such as shaking hands, giving directions to a stranger, finding a way according to the map, and so on. To give directions, for example, the individual must imagine him/herself standing as the other person to work out the route that the stranger needs to take. In other words, he/she would have to imagine and view the physical surrounding through another person's eyes. That would require us to perform an egocentric perspective transformation in the mind; that is, a change in one's imagined position (disembodiment) and aligning one's egocentric orientation in relation to an external perspective.

Children are not capable to view the world distinct from an egocentric viewpoint until the concrete operational stage (e.g. 7-11 years old). For example, Piaget and Inhelder (1948) tried out the three-mountain problem on 4-7 year old children and found that the children always reported what they saw even though they were asked to tell what a doll, placed in an opposite position, would see. Although later researchers have questioned Piaget's division on children's age (e.g. Donaldson, 1978; who suggested that children



with age 3.5-5 years old are already able to transform their egocentric perspective), it is generally accepted that the ability of perspective taking emerges alongside children's cognitive development.

Egocentric perspective transformation is a process that engages the processing of self and body representation, which distinguishes it from the normal object-based mental rotations. Although the two processes seem likely, a strong dissociation has been reported between processes of object-based mental rotation and egocentric perspective transformation (Amorim & Stucchi, 1997; Hegarty & Waller, 2004; Huttenlocher & Presson, 1973; 1979; Presson, 1982; Simon & Wang, 1998; Wang & Simon, 1999; Wraga, Creem, & Proffitt, 2000; Zacks, Mires, Tversky, & Hazeltine, 2000). In addition, there is preliminary evidence suggesting that the object-based mental rotations and the egocentric perspective transformations depend on different neural structures (Creem et al., 2001; Kosslyn, DiGirolamo, Thompson, & Alpert, 1998; Zacks et al., 1999). Each of these processes can be selectively impaired following localised brain lesions (Ratcliff, 1979; Semmes, Weinstein, Ghent, & Teuber, 1963), each one giving rise to different patterns of local brain activity (Zacks et al., 1999), and relating systematically to stimulus presentation and individual differences in spatial ability (Zacks et al., 2000). Therefore, the egocentric perspective transformation is argued to be beyond the normal mental rotation processes by being particularly related to the coding of the self.

Furthermore, it was suggested that imagining taking another perspective and actually taking another perspective might employ a common mechanism. Wohlschlagger and Wohlschlagger (1998) have reported that response times for mental and manual translation of an object are consistent. And accordingly, they concluded that rotary manipulation and mental rotation share a common process in the brain, which is thought to control both real and imagined rotations. In line with this, the (mental) egocentric

perspective taking was believed to share a common mechanism in the brain with that actually taking the perspective out of the body (Arzy et al., 2006). The later execution rarely happens with most individuals but some researchers have found a coherent relationship between out-of-body experience (OBE) and mental perspective taking (Amorim, 2003; Blackmore, 1982; Brugger, 2002; Cook & Irwin, 1983). An OBE is a special form of egocentric perspective transformation; it is a distortion experience in the spatial unity of self and body that the individuals feel themselves as they locate outside of their bodies and view the world from an elevated position (Blanke & Mohr, 2005). Findings (Amorim, 2003; Blackmore, 1982; Brugger, 2002; Cook & Irwin, 1983) have suggested that the mental transformation and OBEs activate a similar brain area (i.e. TPJ). In other words, seeing oneself from another perspective (OBEs) and imagining seeing oneself from another perspective trigger an overlapped brain region. Therefore, if any conclusion can be drawn based on the mental transformation task, it should be plausible to apply it to corresponding actual activities.

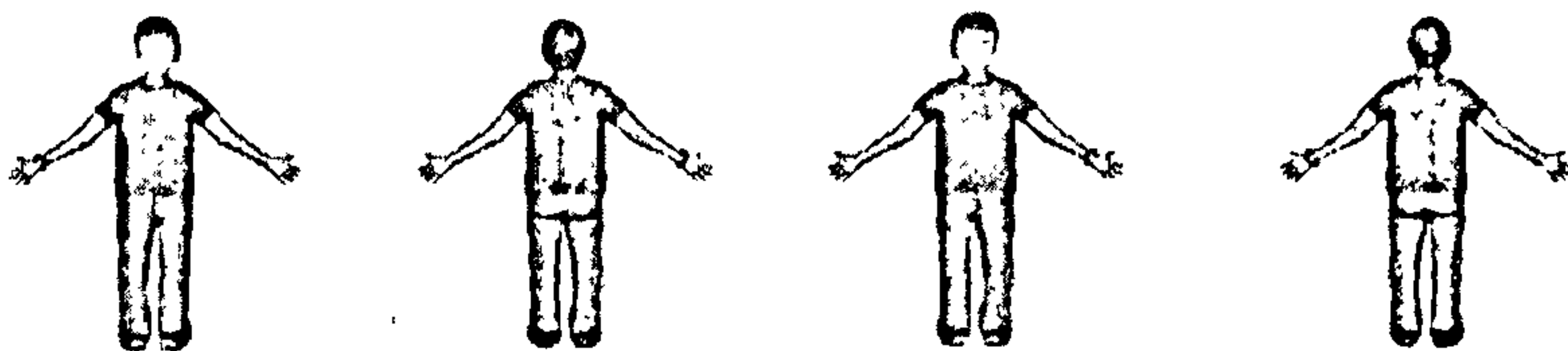
The present study applied a mental transformation task to investigate the egocentric perspective transformation (disembodiment) process in a normal population. Participants were required to make a left/right decision by mentally taking the perspective of a stimulus person (see Figure 5.1). Participants must decide whether, after imagining standing as the drawing person (Steve or Samantha), the right or left hand is marked. Their reaction times of the decision were then recorded.

When the figure is facing away from the participant (herein referred to as back-facing), the indicated hand corresponds with one's own right/left orientation. So the figure is intuitively conceivable as oneself and a judgement is simpler to make. However, if the figure is facing towards the participant (front-facing), there is a body orientation disagreement. It necessitates an additional mental rotation (further cognitive movement) of

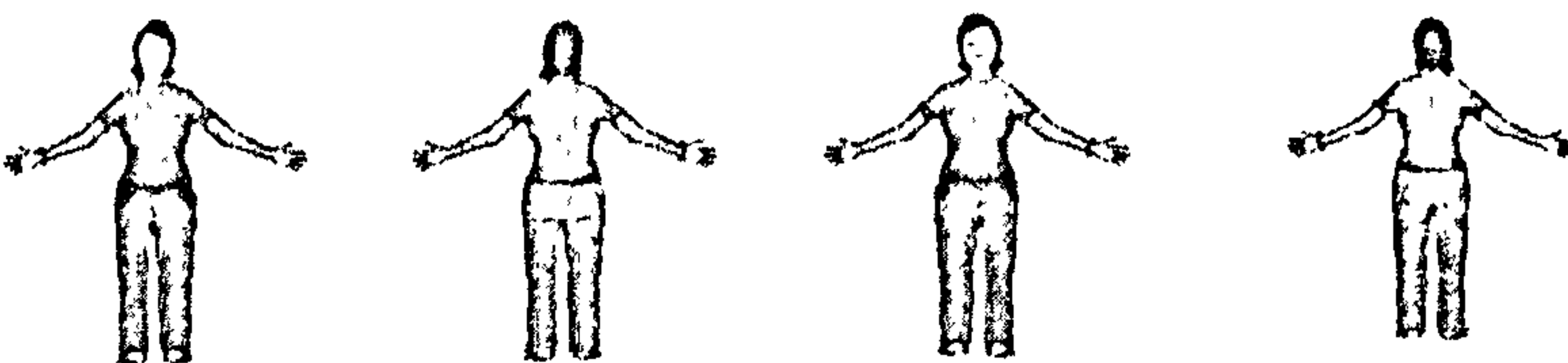


the self to attain a concordant perspective orientation, as shown by longer reaction time (e.g. Arzy et al., 2006; Blanke et al., 2005; Ratcliff, 1979; Zack et al., 1999). Even so, the disembodiment transformation is not only performed for the more cognitively demanding front-facing figures but also for the back-facing figures (Blanke et al., 2005; Mohr, Blanke, & Brugger, 2006; Zack et al., 1999). The process of mental perspective taking was empirically tested through the use of simple line drawings of human figures, which have been demonstrated to be reliable (see Blanke et al., 2005; Parsons, 1987; Ratcliff, 1979; Zack et al., 1999).

#### Steve



#### Samantha



*Figure 5.1.* Stimuli used in the disembodiment/embodiment task.

Furthermore, the cognitive styles are hypothesised to affect the disembodiment process and consequently affect the performance of the transformation task. The WA cognitive style might be an influential variable as it entails the ability to disembed a part from the whole. Analytic individuals are characterised with greater disembedding abilities compared to wholist ones. Hence they will naturally have more ease to disengage from the egocentric view (disembodiment) and result in it feeling easier to take another person's perspective. Hence, it could be logical to infer an analytic individual superiority in the transformation task.

However, the argument can be hypothetically reversed. If the egocentric perspective transformation process invokes greater reliance on empathetic processes (e.g. Davis et al., 2004; Vogeley & Fink, 2003) one may expect a wholist advantage, as wholist people are suggested to be more group dependent and socially friendly (Riding & Rayner, 1998). This point will be covered more in Subsection 5.1.2 in relation to empathy.

The VI cognitive style is also thought relevant because of its capability to manipulate the focus of behaviours (Riding & Rayner, 1998). Imagers are able to build an image of the world without interaction with others and keep inward (internal focus). They are assumed to have a disadvantage during the disembodiment task because their internal focus might interfere with such a disembodying process by the tendency to stay with their own perspective. Verbalisers, in contrary, are more outward because the communicability of the verbal representation encourages them to be more externally focused. Thus, it may help them in the disembodied task performance.

### *Embodiment*

The embodiment process was suggested to relate especially to the left extrastriate body area (EBA) in the lateral occipitotemporal cortex (Arzy et al., 2006; Astafiev, Stanley, Shulman, & Corbetta, 2004; Downing, Jiang, Shuman, & Kanwisher, 2001). Embodiment (i.e. feeling the self inside the body) is a solid basis of the concept of the self (Churchland, 2002; Gallagher, 2005; Kircher & David, 2003; Tsakiris & Haggard, 2005). We own a body, which we move and feel, and with which we interact with the world. Upon this basis, we build up a personal history and consequently become who we are. Distortions of the embodiment process are frequently relevant to psychological disorders. For instance, the disturbing experiences of embodiment have often been reported linked to schizophrenia or schizotypy (e.g. Angyal, 1936; Bleuler, 1950; Burrack & Brugger, 2005; Chapman, Chapman, & Raulin, 1978; Lenzenweger, 2000; Meehl, 1990; Mohr et al.,



2006).

However, the embodiment of self location is rather difficult to investigate solely. Normal people hardly have any trouble of the sense of embodiment, and so have hardly any feeling of it. As such, there is less evidence reported for this concept compared to the disembodiment. A few studies have revealed a body position (congruent or incongruent) effect on embodiment that the body location actually influences the brain activities during embodied self location (e.g. Arzy et al., 2006). Arzy et al. (2006) concluded that the embodied self location and the actual body location may also share neural mechanisms at EBA.

In the present study, an embodiment task was introduced as a control task that employed the exact same stimuli as the disembodiment task (shown in Figure 5.1), but required an embodied perspective. The identical use of the stimuli with the same orientations of the visuospatial perspective (back- and front-facing) and the same response mode (left/right judgement) minimised the possibility of introducing additional variables. In this task, by imagining themselves looking at a mirror (the stimulus person is the mirror reflection), participants would perceive their real intracorporeal position (i.e. keep embodied self location) (Arzy et al., 2006). Here an opposite pattern of responses is expected, when compared to the disembodiment task. In the mirror (embodiment) task participants are expected to respond faster to front-facing figures as a more common experience in daily life. The back-facing figures, which are a relatively rare experience, would require an extra mental rotation and thus take longer judgement times (Arzy et al., 2006).

If the cognitive styles (both WA and VI) are merely relevant to the disembodiment process, they should not have any effect on the performance of the control (embodiment) task. In contrast, if the cognitive styles show a similar pattern on both tasks, they should be

related to a joint underlying mechanism of both tasks, for example, an integrated bodily image process. This hypothesis will be further discussed in the discussion section.

### *5.1.2 Empathy*

The ability to take the perspective of others may not only concern the spatial self representations but also emotional mental states. By taking another's perspective emotionally, one could predict what the other person is feeling, so as to respond appropriately. This introduces a new variable into the present study, namely, empathy.

Overall, empathy has been agreed as having two main strands (Baron-Cohen & Wheelwright, 2004): the cognitive empathy and the affective empathy. The cognitive empathy refers to the process that understands others' feelings. To achieve this, individuals have to first push aside his/her own current feeling and put the self into the mental state of another person (Leslie, 1987). In short, cognitive empathy involves the ability to predict another's mental state and resulting behaviour (Dennett, 1987). Affective empathy, in contrast, describes an observer's emotional responses to the affective states of other persons. It may involve both the matching response of the target (e.g. frightened by seeing someone's anger) and affection that goes beyond a simple matching feeling like sympathy and compassion (Davis, 1994). Besides that, only appropriate other-orientated mental responses can be regarded as affective empathy. Consequently, the combination of the cognitive and affective empathy leads to the common understanding of 'empathy'.

To explain empathy, Baron-Cohen and Wheelwright (2004) conceptualised a model with two profiles, empathising and systemising, as two major dimensions. These two systems are independent but have an effect on each other and possibly a trade-off relationship. Empathising is the drive to comprehend another's mental state and to provide responses with appropriate emotions. Systemising refers to the capability to analyse and derive the underlying rules and regularities that govern behaviours. While systemising aids



our understanding of how the world works when rules are applied, empathy allows us to identify with another person's emotions, essentially to 'mentally put ourselves into someone else's shoes'. Usually, one's empathising ability is inversely correlated with systemising ability. For instance, the better at systemising a person is, the less empathetic he/she is (Baron-Cohen, Richler, Bisarya, Gurnathan, & Wheelwright, 2003).

A female superiority has been constantly replicated in studies and women are usually reported as being more empathetic than men in the healthy population (e.g. Baron-Cohen et al., 2003; Baron-Cohen & Wheelwright, 2004; Davis, 1980; Davis & Franzoi, 1991; Hoffman, 1977; Lawrence, Shaw, Baker, Baron-Cohen, & David, 2004). Baron-Cohen and his colleagues explain such a gender bias by the Extreme Male Brain theory of autism (see Baron-Cohen & Wheelwright, 2004). They categorised individuals on the autistic spectrum as exaggerated cases of a severe tendency towards the systemising process, that is, an extreme male brain. According to the theory, the so-called male brain is defined as an individual who is predominant with the systemising process while the female brain refers to the predominant empathising process. Accordingly, women are more empathetic because they are more likely to be 'female brained'. (However, as unavoidable limitation for all self-report measures, Baron-Cohen and Wheelwright (2004) admitted that the female superiority could be possibly attributed to the fact that women have greater social desire to *report* empathetic behaviours.) In line, there was found to be significantly more male autistic patients than female ones (a gender ratio of 8:1; Wing, 1981). On the other hand, autism could be regarded as an empathy disorder because of the patients' deficits of mindreading, which has been proved by many studies (Baron-Cohen, 1995; Baron-Cohen & Wheelwright, 2004; Gillberg, 1992; Yirmiya, Sigman, Kasari, & Mundy, 1992).

The autistic individuals (having deficits of empathic behaviours) were described as

having a 'fragmental view of the world' by which they see everything in parts rather than a coherent whole situation (Frith, 1989). Besides, an autistic superiority was found on the EFT (i.e. an analytic aptitude), which associated autistic spectrum with global- versus local- processing differences (Jolliffe & Baron-Cohen, 1997; Shah & Frith, 1983). Frith (1989) suggested that people with autism showed a detail-focus type of information processing at the expense of global configuration and contextualised meaning. This line of research pointed to a potential connection between the WA dimension of cognitive style and the systemising-empathising-process-balance. If the autistic spectrum (which is inversely correlated with the empathic spectrum) increases with the global-local processing difference (which is proposed to be a major feature of the WA cognitive style), it is suggested to associate with the WA cognitive style, too.

In addition, the wholist (/FD) individuals have been described as tending to be more social than their analytic (FI) peers (Witkin & Goodenough, 1977). They prefer contacts with others, activities involving social interaction, and are more open to their feelings. Wholist people are usually characterised as displaying warmth, affection, tact, and accommodation. In comparison, analytical people appear to be more cold and distant (Witkin & Goodenough, 1977).

Therefore, wholist participants would be expected to report higher scores of empathy as they are usually thought to be social dependent and to interact more with others. In contrast, analytic participants may exhibit rather impaired overall empathic records since they tend to be more systemising.

Empathy, especially the cognitive component of empathy, was thought to entail the emotional form of egocentric perspective transformation (disembodiment) process (Davis et al., 2004; Vogeley & Fink, 2003). Researchers have theoretically linked the (cognitive) empathy with perspective-taking tasks such as role-taking (Mead, 1934), non-egocentric



responding (Piaget, 1932) etc. Therefore, the disembodiment process and cognitive empathy are suggested as sharing an overlapped underlying mechanism.

Hence, it is also reasonable to assume that analytic people show higher cognitive empathy. Similar to egocentric transformation (disembodiment), to empathise cognitively with someone, individuals need to first 'disembed' from their current mental state and think about the contents of another's mind. Thus, analytic people who have better disembedding ability are assumed to have benefits during this process.

The VI dimension of cognitive style may also affect the empathy. Verbalisers are supposed to more frequently represent the external world with abstract descriptions (inner speech) whilst imagers represent the world by mental pictures. Therefore imagers would exhibit better empathy than verbalisers since the concrete pictorial representations enable them to imagine a social setting with details which the others are experiencing, and consequently this helps them to empathise the emotional state (e.g. 'Lily intends to give a speech in public. ... There is a crowd. ... They are all staring at her. ... They are whispering. ... I would be very nervous if I was her.').

### *5.1.3 Attachment*

One's experiences in infancy and early childhood with parents are very important in influencing later life activities. It is the centrepiece of many theories about attachment (e.g. Bartholemew & Horowitz, 1991; Bowlby, 1969; 1973; Hazan & Shaver, 1987; 1990; Simpson & Rholes, 1998). Early attachment experience is the basis for everyone to form a life-long unique personality style by which one socially interacts with others. It is easy to understand that if an infant receives a sensitive and responsive care from parents, s/he would be more likely to regard herself/himself as love-worthy and others as dependable. And such an impression could last throughout their lifespan. In comparison, if a person experiences neglect, a lack of response, or inconsistent care during infancy, s/he may hold

the beliefs that the self is worthless and/or others are unreliable. These impressions from infancy attachment experiences are probably guiding the person's affect and cognition even into adulthood, especially in the attachment-related situations (e.g. Bartholemew & Horowitz, 1991; Hazan & Shaver, 1987; Mikulincer, 1997).

In 1991, Bartholemew and Horowitz proposed a model of attachment with two distinct underlying dimensions concerning the beliefs and feelings about the self and others. These were anxiety (i.e. the extent to which a person strives to maintain proximity with others due to insecurity) and avoidance (i.e. the extent to which a person strives to maintain emotional distance due to insecurity in their relationships with others).

Individuals who are anxiously attached (i.e. score highly on the anxiety dimension) have negative representations of themselves. For example, they regard themselves as unworthy of love and fear abandonment by attachment figures (e.g. parents, lovers, close friends, etc.). As a result, they would usually experience a low level of social-confidence and be more likely to hold an obsessive, dependent relationship with their loved ones (Collins & Read, 1990).

Those who are avoidantly attached (i.e. score highly on the avoidance dimension) have negative representations of others. They would regard their partners in their relationships as not trustworthy or reliable. (Note that in this chapter the term 'partner' does not necessarily refer to the partner in a romantic relationship, but also refers to the one being attached to in other kinds of relationships, such as friends, family members, etc.) As a result, they feel uncomfortable sharing intimacy with others and maintain their independence from partners (Brennan, Clark, & Shaver, 1998; Mikulincer, Shaver, & Pereg, 2003; Rowe & Carnelley, 2003).

In contrast, the secure attached people (i.e. those who score low on both dimensions) are holding positive beliefs about themselves and others, and consequently feel



comfortable with closeness and independence in relationships (Hazan & Shaver, 1987; Kirkpatrick & Davis, 1994; Mikulincer & Erev, 1991; Pietromonaco & Carnelley, 1994). Those who have a secure attachment were also found to have developed constructive coping responses to stressful situations, to seek more social support, and to report fewer feelings of distress than insecure individuals (Mikulincer, Florian, & Weller, 1993; Simpson, Rholes, & Nelligan, 1992).

The two attachment dimensions of the self and others (anxiety and avoidance, respectively) are suggested to vary independently (Bowlby, 1973). This assumption is empirically supported by the four attachment style groups (i.e. secure, preoccupied, fearful, and dismissing) in the populations assessed by the two attachment dimensions (e.g. Bartholomew & Horowitz, 1991; Brennan et al.; Hazan & Shaver, 1987; etc.). Although the secure and fearful attached individuals have a congruent disposition (e.g. positive or negative, respectively) in both attachment dimensions, there are individuals who demonstrate contrasting valences in the two dimensions. For instance, preoccupied (attached) people have negative beliefs/feelings of the self but they have positive perceptions of others. Dismissing people, in contrary, hold negative impressions of others, but a positive image of the self.

Additionally, the anxiety and avoidance dimension of attachment could be regarded as indexes of general evaluations of self and others, resulting from perceptions of parental treatment during the early stages of life (e.g. Bartholomew & Shaver, 1998; Brennan, Clark, & Shaver, 1998; Fraley, Waller, & Brennan, 2000; Luke, Maio, & Carnelley, 2004). It was found that one's attachment anxiety would extensively affect global evaluations of the self with self-esteem and self-confidence (e.g. Bartholomew & Horowitz, 1991; Collins & Read, 1990; Griffin & Bartholomew, 1994a; 1994b; Luke et al., 2004; Murray, Holmes, Griffin, Bellavia, & Rose, 2001), and robustness against psychological distresses

(e.g. Carnelley, Pietromonaco, & Jaffe, 1994; Griffin & Bartholomew, 1994a; 1994b). In summary, the less anxious an individual is with his/her attachment, the higher self-esteem/self-confidence and lower level of distress s/he has. Similarly, there is evidence to associate the attachment avoidance with evaluations of others, such as positive expectations/beliefs of others (e.g. Collins & Read, 1990; Cozzarelli, Hoekstra, & Bylsma, 2000; Feeney & Noller, 1990; Hazan & Shaver, 1987; Mikulincer, 1998), and general humanity-esteem (Luke et al., 2004). The lower the avoidance level of attachment, the more positive and trustful expectations and beliefs the person is holding towards others (e.g. family members, colleagues, and strangers). The attachment styles/dimensions, albeit formed from the basis of specific personal relationships in one's early life, would reflect a more general perception of the self and others (i.e. not merely limited to the caregivers in early childhood) and result in differing social attentions.

For instance, a positive attachment was reported to associate with an aptitude of exploration of new stimuli and environments (Mikulincer, 1997) and empathetic behaviour towards people (Mikulincer, Hirschberger, Nachmias, & Gillath, 2001). However, people with highly anxious attachment were found to pay redundant attention to others and search for even slight signals from others' behaviours (Mikulincer et al., 2003). This is because they always feel the worthlessness of the self and constantly fear abandonment from others. The anxious attachment does not provide them with a secure base to keep social independence and results in an other-oriented bias of their perceptions. Hence, their attentions are over-preoccupied with interpersonal relationships and overly focusing on others in social environments.

Similarly, the avoidant attachment was found to be related to strategies that involve avoidance of new information (Mikulincer, Shaver, & Pereg, 2003), lack of empathic responses to others who are in suffering (Westmaas & Silver, 2001), and negative



correlation with self reported communion (which reflects a concern for others; Shaver et al., 1996). It was suggested that, because of mistrust, avoidantly attached individuals have a rather compulsive self-oriented attention (to maintain the emotional distance) in social environments and dismissing others' feelings (Mikulincer, Shaver, Gillath, & Nitzberg, 2005). In conclusion, the two dimensions (anxiety and avoidance) of attachment are not only relevant to the beliefs individuals hold with themselves and others, but also reflects the attention orientations of their social perception/behaviour.

On the other hand, cognitive styles have long been argued to relate to the self and non-self concept. The WA cognitive style (FDI style) was suggested to increase with self-reliance and decrease with interpersonal dependence (e.g. Korchin, 1986; Witkin, Goodenough, & Oltman, 1979). In sum, wholist people were suggested to be more socially dependent, whilst analytic people were postulated to be more self-reliant during interactions with others (Riding, 1991). For example, FIs have been found to be less sensitive to social cues (Witkin et al., 1971) and show less incidental learning of social materials than FDs (but not differing in non-social stuff; Eagle, Goldberger, & Breitman, 1969; Fitzgibbons, Goldberger, & Eagle, 1965). Paul (1975) also reported a connection between less separation anxiety and better performance on disembedding ability (FIs). A survey investigating personal characteristics of undergraduate students who were living in joint university accommodation revealed that wholist students were seen as more assertive, helpful and humorous (other-oriented personalities) compared to analytic students who were shyer (self-oriented personality) (Riding & Wright, 1995). Riding and Wright also reported that analytic students behaved more separately than wholist ones during interactions with flatmates.

The VI cognitive style, which affects the representation mode of information, may influence the self- or other- orientation of social perception too, by manipulating the focus

of activity (Riding & Rayner, 1998). Verbalisers are externally focused and socially active because they tend to explore the outward world with linguistic descriptions and rules (which is suggested to be a more interactive mode). Imagers are thought to be internally focused and more socially passive, as they are capable of building an image of the environment without interaction with others and tend to keep inward emphasis. Riding and Dyer (1980) reported a strong correlation between the VI cognitive style and the introversion-extraversion dimension of personality among 12-year-old children. And the 'verbal children' were reported to appear more socially active, as reported by their classmates while 'imagery children' were reported to be more socially passive (Riding, Burthorn, Rees, & Sharratt, 1995).

#### *5.1.4 Hypotheses*

According to the above review, hypothesised relationships between the cognitive styles and participants' performances on differed facets of self concept can be elicited by taking each cognitive style dimension in turn.

##### *The WA Cognitive Style*

1) Concerning the embodiment/disembodiment tasks,

H1a. Analytic participants will exhibit better performance than wholist participants in the disembodiment task because of their superior disembedding ability.

Or, the hypothesis can be theoretically reversed,

H1b. Wholist participants will be favoured in the disembodiment task compared to the analytic participants for their empathic nature.

Additionally, the embodiment task as a control task is not expected to demonstrate any difference if the WA cognitive style is only related to the disembodying process.

2) Concerning the empathy scores,

H2. Wholist participants will manifest higher scores in empathy than analytic



participants.

H3. Nevertheless, analytic participants may manifest higher scores in cognitive empathy than wholist participants because of the overlapped mechanism between the cognitive empathy and the spatial disembodiment task (i.e. requiring disembedding ability).

3) Concerning attachment anxiety/avoidance,

H4. Wholist participants will report a higher level of attachment anxiety than analytic participants because they tend to behave more socially dependent (other-oriented).

H5. Analytic participants will report a higher level of attachment avoidance than wholist participants because they are more separate from others and self-reliant during social activities (self-oriented).

#### *The VI Cognitive Style*

1) Concerning the embodiment/disembodiment tasks,

H6. Verbal participants will show better performance in the disembodiment task as the inward tendency of imagery participants might interfere with the disembodiment process.

The performance of the embodiment task is expected to be untouched by the VI cognitive style as there is no disembodiment process..

2) Concerning the empathy scores,

H7. Imagery participants will express higher empathy scores because of their capability to concretely represent the empathic situations.

3) Concerning attachment anxiety/avoidance,

H8. Verbal participants will show a higher level of attachment anxiety than imagery participants as they are rather socially active (other-oriented).

H9. Imagery participants will show a higher level of attachment avoidance than verbal participants for their social passivity (self-oriented).

## 5.2 Method

### 5.2.1 Design

In both the transformation (disembodiment) task and mirror (embodiment) task, there was a 2×2×2 mixed design with the WA cognitive style (wholist versus analytic) and the VI cognitive style (verbaliser versus imager) as the between-subject factors and position of the figures (back-facing versus front-facing) as the within-subject factor. Reaction times to the stimuli in the two tasks were measured as the dependent variables.

For empathy, a correlational design was employed. The WA ratios and VI ratios of CSA and the empathy scores worked as independent variables.

A correlational design was also used in the attachment section. The WA and VI style ratios in conjunction with scores of attachment anxiety and avoidance scales were the independent variables.

### 5.2.2 Participants

One hundred and thirty undergraduate psychology students (66 female, 64 male) participated in the study for course credit or financial reward (except four work experience students who took part in the study voluntarily). Participants have a mean age of 20.11 years (SD = 3.20 years). All participants reported normal or corrected to normal vision and were pre-selected to be right handed.

### 5.2.3 Materials

*Disembodiment and Embodiment Task.* The stimuli used in the embodiment/disembodiment tasks modified from those used in previous mental own-body transformation studies (Mohr, Blanke, & Brugger, 2006). The schematic human figures involved four standing males (Steve) and four of standing females (Samantha) in order to avoid any single gender bias of the stimuli themselves (see Figure 5.1). The figure was either front- or back- facing from the participants, with a black ring around one of its hand.



The position of the figures (front-/back-facing) was distinguished by the cloth rendering and the presences of a face or hair.

*Empathy.* The Empathy Quotient (EQ) questionnaire was employed to determine one's level of empathy (Baron-Cohen & Wheelwright, 2004; see Appendix D). The EQ comprises 60 questions, of which 20 are filler items to prevent participants from guessing the purpose of the questionnaire. The remaining 40 questions concern empathic behaviours in daily life with half of the questions are reversed. Participants were required to rate each question according to a 4-point scale; 'strongly agree', 'slight agree', 'slight disagree', and 'strongly disagree'. Non-empathic responses were scored 0 (i.e. respond disagree to empathic questions or respond agree to reversed questions). 2 or 1 point was granted to participants for empathic response depending on the strength of the reply (i.e. 'strongly...' or 'slightly...'). Thus, every participant's empathy score varied from 0 to 80. The presentation of questions was randomised.

The EQ is supported to be a reliable and valid measure of empathy. Its test-re-test reliability was reported to be high over a period of 12 months ( $r > 0.83$ ; Lawrence et al., 2004). It was shown to distinguish reliably between clinical groups, such as those who are diagnosed with autistic disorder and suggested to have problems employing 'empathy' (Blair, 1995), and healthy groups (Baron-Cohen & Wheelwright, 2004; Lawrence et al., 2004). The EQ was also highly correlated with other empathy-related measures (Baron-Cohen & Wheelwright, 2004; Lawrence et al., 2004).

Further, the responses of the EQ were sub-divided into three subscales based on previous research (Lawrence et al., 2004) to separate the scores on the cognitive empathy, affective empathy, and social skills (for categorisation of the items see Appendix E). The latest component, which was suggested to emphasise well trained conditional skills in social environment, is argued to relate little to intuitive empathic understandings.

*Attachment.* The two dimensions of attachment (anxiety and avoidance) were measured using a revised version of the Experiences in Close Relationships Questionnaire (ECR; Brennan et al., 1998; see Appendix F). The original questionnaire was designed for investigating attachment behaviour with romantic partners. However, the revised version of the ECR modified attachment target to general close others (including romantic partners, family members, friends, etc.) by replacing references to romantic partners with references to general close others (Luke et al., 2004; Rowe & Carnelley, 2003; 2005). For example, 'I prefer not to be too close to romantic partners' was revised into 'I prefer not to be close to others.'

The ECR questionnaire consists of 36 items. Participants were required to indicate the extent to which they would agree with each of the statements on a 7-point scale; from 'strongly disagree' (score 1) to 'strongly agree' (score 7). Half of the statements are anxiety-related while the rest are avoidance-related. The final attachment scores are the average of responses of relevant statements (anxiety and avoidance). In addition, to balance the possible response bias, 14 of the 36 items are reversed. Those responses were reversed before being calculated into final scores (e.g. a response '1' was re-keyed as '7' before averaging).

Evidence from previous studies has supported the ECR with high internal consistency (generally  $> 0.80$ ; Brennan et al., 1998; Rowe & Carnelley, 2003; 2005) and validity that it has highly correlated with other multi-item self-report measures of romantic attachment ( $r \approx 0.80$ ; Crowell, Fraley, & Shaver, 1999).

The ECR questionnaire provides both a dimensional (e.g. one's position along the anxiety and the avoidance continuum) and a categorical measure of attachment style. However, in the present study only the dimensional scores were included in analyses.

*Cognitive Styles.* Participants took CSA (Riding, 2005) to report their positions on



the WA and the VI cognitive style dimensions.

#### *5.2.4 Procedure*

Participants were tested individually in a quiet room.

They were first asked to perform the computerised disembodiment/embodiment tasks. Stimuli in both tasks were identical. In each trial, a figure preceded by a fixation cross on the screen for 500 ms and then remained in the centre of the screen until 4000 ms or a response was made. It automatically proceeded to the next trial. The internal stimuli interval was 1000 ms. The instructions differed between the two tasks. In the transformation (disembodiment) task, participants were asked to imagine transforming themselves into the position and orientation of the figure they saw on the computer screen and then decide whether the indicated hand (with a black ring) would be their right (press right shift key) or left hand (press left shift key). In the mirror (embodiment) task, they were told to imagine that the figure on the screen was their mirror reflection, as seen from a habitual point of view, and then decide which of their hands was indicated by the ring. Again, the right shift key referred to right response and left shift key referred to left response. Participants were required to respond as quickly and accurately as possible to each trial, and always to perform the instructed mental imagination prior to giving any response. Either task (transformation or mirror) included 80 trials, which consisted of 10 presentations of each stimulus ( $10 \times 8$ ) in a randomised order. To counterbalance the order effect, half of the participants performed the transformation task first, and the others did the mirror task first.

Finally, participants completed the EQ and ECR questionnaires on paper followed by the CSA test, and were thanked and debriefed.

#### *5.2.5 Data Analysis*

Two one-way ANOVAs with gender (men versus women) as a between-subject

factor were conducted on the WA and VI cognitive style ratios. The intention was to determine whether gender would have any effect on the cognitive styles in the present sample. The result revealed that gender did not affect people's VI cognitive style ( $p > .29$ ; men  $1.05 \pm 0.12$  versus women  $1.03 \pm 0.11$ ) but females did appear to be more wholist ( $1.05 \pm 0.25$ ) than male ( $1.22 \pm 0.37$ ),  $F(1,128) = 9.79, p < .01$ . In addition, the WA cognitive style ratios were found to be positively correlated with the VI style ratios in the present sample,  $r(130) = .248, p < .01$ . The reason for the gender difference on the WA dimension and the correlation between the two dimensions of cognitive style were inconsistent with the literature (e.g. Riding, 1997) but they are included in the analyses to control for any possible confounding effects.

### 5.3 Results

To separate the sample into cognitive style groups, 130 participants were split based on their median ratios on the WA dimension and the VI dimension (Riding, 2005). The details of the division could be seen in Table 5.1.

Table 5.1  
*The division of the cognitive style groups*

|                                   | Verbaliser<br>(ratios $\leq 1.01$ ) | Imager<br>(ratios $\geq 1.02$ ) | Total |
|-----------------------------------|-------------------------------------|---------------------------------|-------|
| Wholist<br>(ratios $\leq 1.07$ )  | 33                                  | 32                              | 65    |
| Analytic<br>(ratios $\geq 1.08$ ) | 30                                  | 35                              | 65    |
| Total                             | 63                                  | 67                              | 130   |

#### 5.3.1 Disembodiment/Embodiment Task

Mean reaction times for correct responses were calculated for the disembodiment/embodiment tasks. Any non-responses and response latencies faster than 200 ms were discarded from further analysis (Harris, Harris, & Caine, 2002). Four



participants were excluded from mirror task data set because of a low number of correct responses (accuracy < 75%). However, their transformation task performance remained for analysis.

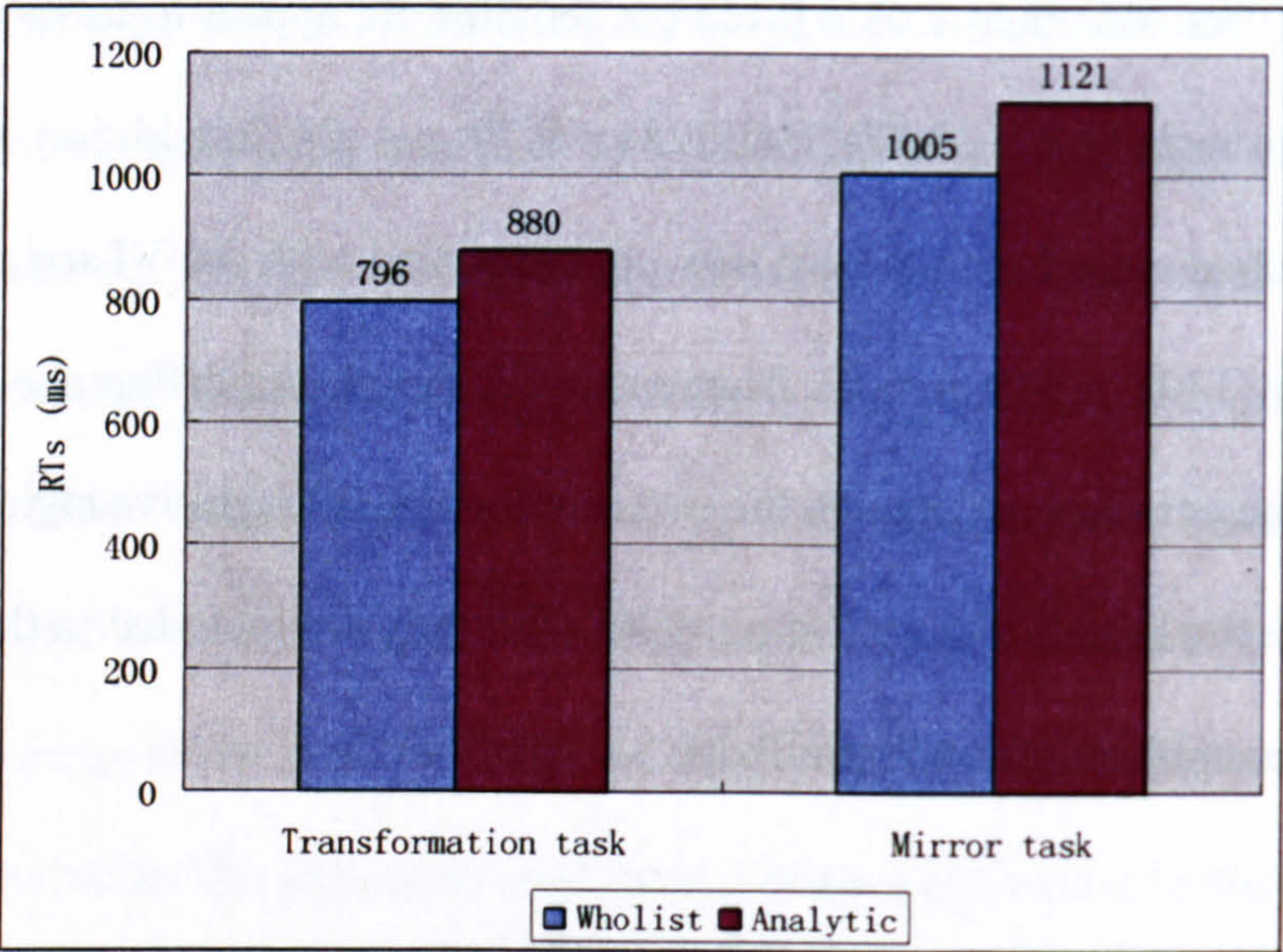


Figure 5.2. Reaction times of wholist and analytic participants in the embodied/disembodied tasks

A 2×2×2 mixed sample analysis of variance with covariance (ANCOVA) was performed on the average reaction times of the *transformation* (disembodiment) task, with the position of figures (back-facing versus front-facing) as a within subject factor, the WA (wholist versus analytic) and the VI (verbaliser versus imager) style groups as between subject factors, and gender (men versus women) as the covariate.

A significant main effect of the position of figures was shown as response latencies were longer for front-facing figures (928 ms) compared to back-facing figures (749 ms),  $F(1, 125) = 73.79, p < .001, \eta_p^2 = 0.37$ , which replicated previous findings (Blanke et al., 2005; Mohr et al., 2006; Zack et al., 1999). Such a reaction time difference of position in the transformation task indicated that participants have used mental rotation as a processing strategy, which suggested a successful manipulation that worked in a way as had been expected. Notwithstanding, the position of figures did not significantly interact



with any cognitive style groups (all  $p > .32$ ) or with gender ( $p > .50$ ).

The WA cognitive style groups were found having a significant main effect on the reaction times of the transformation task ( $F(1, 125) = 4.41, p < .05, \eta_p^2 = 0.04$ ) with wholists responding generally faster in the task (796 ms) than analytics (880 ms).

The effect of the VI cognitive style groups failed to reach significance (verbalisers, 857 ms versus imagers, 819 ms;  $p > .33$ ), neither its interaction with the WA cognitive style groups ( $p > .46$ ).

Gender did not show an effect on the reaction times of the transformation task ( $p > .57$ ).

The same  $2 \times 2 \times 2$  mixed sample ANCOVA was then conducted on the mean reaction times of the *mirror* (embodiment) task. Similarly, the position of figures had a significant main effect on the speed of response,  $F(1, 121) = 35.12, p < .001, \eta_p^2 = 0.23$ . Participants responded faster to front-facing figures (970 ms) in the mirror task compared to the back-facing figures (1156 ms), which again support the manipulation of the study (Arzy et al., 2006). Furthermore, the position  $\times$  gender interaction was found significant ( $F(1, 121) = 4.28, p < .05, \eta_p^2 = 0.03$ ) that women responded quicker than men when they faced figures in the front-facing positions in the mirror task (939 ms versus 1002 ms) but had similar response latencies with men to the back-facing figures (1165 ms versus 1141 ms). None of the other interactions with position was found significant (all  $p > .08$ ).

Similar findings of the WA and the VI cognitive style groups with the transformation task were revealed in the mirror task. The WA style groups showed a significant main effect on the mirror task reaction times,  $F(1, 121) = 5.65, p < .05, \eta_p^2 = 0.05$ . Wholist participants again exhibited overall shorter response latencies (1005 ms) than analytic participants (1121 ms). See Figure 5.2. However, it did not interact with other independent variables (all  $p > .11$ ). The VI style groups responded to the task in at



similar speeds (verbalisers, 1047 ms versus imagers, 1075 ms;  $p > .64$ ), and did not interact with the WA style groups ( $p > .11$ ).

Gender did not have a main effect on the reaction times of the mirror task ( $p > .94$ ).

5.3.2 Empathy

Mean EQ scores were showed in Table 5.2.

Table 5.2  
*Descriptive statistics of the EQ scores (n = 130)*

|      | Overall Empathy | Cognitive Empathy | Affective Empathy | Social Skills |
|------|-----------------|-------------------|-------------------|---------------|
| Mean | 44.68           | 13.78             | 11.28             | 6.98          |
| SD   | 10.02           | 4.15              | 4.12              | 2.29          |

A series of one-way ANOVAs were applied and gender differences were found on the EQ scores (overall empathy, cognitive empathy, affective empathy, and social skills). Women did score significantly higher than men on overall empathy (48.97 versus 40.25,  $F(1,128) = 30.14, p < .001$ ). However, when separating items into subscales, it revealed that men did have the same level of cognitive empathy (13.27 versus 14.27) and social skills (6.92 versus 7.03) as women (both  $p > .16$ ). The only empathic difference between men and women was the affective empathy (8.89 versus 13.61,  $F(1,128) = 63.00, p < .001$ ). Women seemed more capable of responding intuitively to others' emotions compared to men.

Table 5.3 displays partial correlations between each of the two cognitive style ratios and the EQ scores after controlling for gender and the other dimension of cognitive style. That is, when analysing the relationship between the WA style ratios and EQ scores, the VI style ratios and gender were treated as covariates. It was reversed when analysing the VI style ratios and EQ scores. The WA cognitive style showed no effect on any approaches of empathy (all  $p > .32$ ). In contrast, the VI cognitive style positively correlated with the cognitive empathy and affective empathy and the resulting total EQ

scores (all  $p < .05$ ), but not with the social skills ( $p > .63$ ).

Table 5.3

*Partial correlations between the style ratios (WA and VI) and EQ scores*

|           | Total<br>Empathy | Cognitive<br>Empathy | Affective<br>Empathy | Social Skills |
|-----------|------------------|----------------------|----------------------|---------------|
| WA ratios | .036             | -.089                | .048                 | -.035         |
| VI ratios | <b>.231**</b>    | <b>.192*</b>         | <b>.221*</b>         | .042          |

*Note.* The correlations in bold show the significant correlations between the style and the EQ scores after controlling for gender and the other style

\*  $p < .05$ ; \*\*  $p < .01$

Additionally, to examine the hypothesis that the cognitive empathy might share part of the underlying mechanism with the egocentric perspective taking process (see introduction 5.1.2), another Pearson correlation analysis (one-tailed) was employed between the cognitive empathy scores and the overall mean reaction times in the transformation task. However, no significant relationship was found between them ( $r(130) = -.065, p > .23$ ). As a control comparison, the correlation between the cognitive empathy scores and the overall mean reaction times in the mirror task was analysed too;  $r(130) = -.071, p > .21$ .

### 5.3.3 Attachment

Participants had a mean score of  $3.51 \pm 0.91$  for anxiety and  $3.07 \pm 0.88$  for avoidance on the ECR questionnaire. A Pearson correlations analysis suggested independence between the two dimensions of attachment ( $r(130) = 0.15, p > .08$ ). Two one-way ANOVAs found no gender bias on either dimension of attachment (Anxiety: men 3.43 versus women 3.59,  $F(1, 128) = 0.93, p > .33$ ; Avoidance: men 3.20 versus women 3.93,  $F(1, 128) = 3.14, p > .07$ ).

Partial correlation (one-tailed; in order to manifest relation with the cognitive style with more sensibility) after controlling for gender and the VI cognitive style revealed no significant relationships between the WA style ratios and anxiety/avoidance scores, both  $p$



> .19. However, after controlling for gender and the WA cognitive style, the VI style ratios were found to be marginally correlated with the attachment anxiety ( $r(126) = -.137, p = .06$ ) but irrelevant to the attachment avoidance ( $p > .25$ ). A negative correlation with attachment anxiety was found for female participants ( $r(63) = -.213, p < .05$ ) but not for males ( $p > .23$ ) (after controlling for the WA cognitive style).

## 5.4 Discussion

This chapter aimed to investigate the hypothesised relationships between the two dimensions of cognitive style (WA and VI) and self related concepts. Previous research has suggested that both the WA and the VI cognitive style can theoretically (but differentially) associate with the self- or other-related perceptions, which involve, for instance, the embodiment/disembodiment process, empathy-, and attachment-related behaviours (e.g. Korchin, 1986; Riding, 1991; Riding & Rayner, 1998; Witkin et al., 1979; Witkin & Goodenough, 1977). Those hypotheses have been partially confirmed by the results and they will be discussed in turn with the two dimensions of cognitive style separately.

### 5.4.1 *The WA Cognitive Style*

The WA cognitive style has been found to have an effect on the embodied/disembodied tasks. It was initially assumed that the superior disembedding ability of analytic individuals should facilitate the disembodiment process. Accordingly analytic participants should exhibit an improved performance on the disembodied (transformation) task but not on the embodied (mirror) task (H1a). However, it was found that wholist individuals showed superiority in both the embodied and disembodied task after eliminating the confounding effect of gender.

This finding could be explained with other hypotheses concerning empathy and

attachment, respectively: 1) wholists were favoured in the empathy related perspective taking (disembodied) task because they are more empathic (H1b); and/or 2) wholists are more emphasising on social desires (H4) so that they may have spent longer time in front of mirrors, which resulted in an enhanced performance in the mirror (embodiment) task. However combining with the findings of empathy and attachment anxiety/avoidance (other-/self-orientation), the two explanations seem not to be supported.

The WA cognitive style dimension appears to be independent from the empathy continuum (H2 was not supported). Hence, wholist individuals do not entail better empathetic ability to facilitate the egocentric transformation. The first explanation is not likely to be supported.

The finding seems to be conflicting with some previous findings, which have reported an autistic superiority on the EFT (Shah & Frith, 1983; Jolliffe & Baron-Cohen, 1997). It was suggested that people with autism, who are characterised with a detail-focused type of information processing (Frith, 1989), have a strong tendency to be categorised as FIs/analytics. Hence, the WA cognitive style might coincide with the autism spectrum; which was inversely correlated with empathy dimension (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). However, it was found not to be the case in the result.

This could be caused by the fact that the relationship between the WA style and the extent of male/female brain (empathising – systemising balance; Baron-Cohen, 2002; 2003) is not as obvious in normal population as it may appears in the group with autism. It is noteworthy that there were also a few studies, which failed to reveal such an autistic superiority on the EFT (Brian & Bryson, 1996; Ozonoff, Pennington, & Rogers, 1991), suggesting that such a relationship may not be a stable one.

Moreover, the FDI measure (EFT) used in those studies was constantly questioned.



concerning its operational definition (measuring 'style' or 'ability'? See Chapter 2). It is possible that autistic individuals incidentally have a superior ability in locating an embedded shape in a drawing but such ability is not really anything to do with the 'style'. Riding and Wigley (1997) surveyed 340 healthy college students (aged 17-18 years) with a series of measures of personality and attitude, and concluded (using a principal components analysis) a distinct dimension of empathy from cognitive style. Therefore, although previous research has linked the WA cognitive style with varied social tendencies (e.g. Riding & Rayner, 1998; Witkin & Goodenough, 1977), the relationship between the WA cognitive style and empathy needs more studies to substantiate.

Additionally, one's preferred way of organising information (holistic or in parts) appears not to influence self- or other-oriented perception/behaviour. First, wholist participants did not demonstrate more anxiety about how other people would judge him/her (attachment anxiety; H4 was not supported). As a result, they are not more motivated to spend longer in front of mirrors because of the social pressure (i.e. to please their attached figures, such as a romantic partner). Thus the second explanation of the wholist superiority in embodiment/disembodiment tasks is not supported, either. Likewise, analytic people were not more avoidant and self-focused in relationships with their loved ones (attachment avoidance; H5 was not supported), despite they were described as being more distant and separate in their social environments (Riding, 1991; Riding & Wright, 1995; Witkin & Goodenough, 1977), and less interested in social information (Eagle et al., 1969; Fitzgibbons et al., 1965; Witkin et al., 1971). However, it should be kept in mind that this data merely concerns the self-/other-oriented behaviours with close others and it may differ from a more widespread environment with strangers. Probably this is the reason for the inconsistency between the present finding and previous observations of social behaviours with wholist and analytic individuals.

Returning to the first question: if the wholist superiority in the two embodiment/disembodiment tasks was not because of mediating factors such as empathy and attachment anxiety, then what is the reason? The only explanation is the common underlying mechanism of the two tasks. Arzy et al. (2006) who have tested embodiment/disembodiment tasks with EEG recordings have identified activity in the left EBA to be involved in both tasks. It was suggested that EBA is associated with processing and coding of human bodies (e.g. Astafiev et al., 2004; Downing et al., 2001; Grossman & Blake, 2002; Saxe, Jamal, & Powell, 2006; Urgesi, Berlucchi, & Aglioti, 2004). Accordingly, Jeannerod (2004) presumed that this region could be potentially involved within self processing as it may represent the spatial self. Furthermore, Arzy et al. (2006) concluded that EBA was activated by the coding of human bodies and body parts. Whether mentally staying embodied (keeping the spatial self inside the body) or disembodifying the self location (localising the spatial self outside of the body), the process must be based on a holistic bodily self perception. In order to form the perception of the spatial self, an integration of the multisensory body-related information is required. In line with this, wholists are suggested to demonstrate advantage in this integrated bodily self process by their superior ability of holistic organisation. It is probably the reason why they showed enhanced performance in both the embodied/disembodied tasks. However, without a comparative experimental condition (i.e. embodiment/disembodiment of body parts rather than the whole body) it might have reduced the certainty of the assertion. More research related to this issue is required to confirm the hypothesis.

The lack of analytic superiority in the disembodied task and in the cognitive empathy scores suggests that the ability of disembedding a part from a whole has little relevance in terms of the capability of mentally taking another person's perspective, either physically or emotionally. Notwithstanding, the current results did not provide any



supportive evidence to the proposition that the two processes (physically or emotionally taking someone's perspective) may share a common mechanism (Davis et al., 2004; Vogeley & Fink, 2003).

#### *5.4.2 The VI Cognitive Style*

In contrast with the WA cognitive style, the VI dimension of cognitive style showed no effect on the embodied/disembodied tasks. (H6 was not supported.) The tendency of an external/internal focus of the VI cognitive style does not particularly facilitate/inhibit the disembodiment process of the self location at all, neither the embodiment process.

Nevertheless, the VI cognitive style ratios were found to increase with the cognitive empathy scores and affective empathy scores, and consequently the total empathy scores. (H7 was supported.) Imagers exhibited a superiority compared to verbalisers in both understanding other's mental states (cognitive empathy) and providing simultaneous emotional responses to the affective states of others (affective empathy). Imagers, who are characterised with the ability to rebuild mental images of the outside world internally, may elicit more direct experience of others' feelings based on their vivid representations of the situations. In other words, imagers are able to imitate mentally the social setting of others' cognitive states that leading to better empathising. Accordingly, they may also feel more intuitive to offer emotional responses based on the 'first-hand' impression of others' affective states. Verbalisers, who in contrast are inclined to represent information in a more abstract linguistic form-like way, might tend to be more 'systemising' than 'empathising' (Baron-Conhen & Wheelwright, 2004). Thus they are less capable of coding others' emotional states and reacting with simultaneous feedback. Furthermore, the scores of 'social skills' of empathy were found to be independent from the VI cognitive style ratios. This finding coincides with the prediction that this factor of empathy is acquired

from social learning and hence has little relevance to one's own cognitive styles.

In addition, there was found a tendency for the verbal participants to have a higher anxious level of attachment than the imagery ones, but only for female participants (H8 was partially supported). The avoidance scores were found to be independent from the VI cognitive style ratios (H9 was not supported). The VI cognitive style was initially thought to have an effect on the self-/other-oriented social attention by influencing the focus and type of an individual's activities (Riding & Rayner, 1998). Verbalisers are assumed to be externally focused and socially active; hence, they are more likely to be other-oriented (e.g. higher level of attachment anxiety). Imagers are more internally focused and socially passive, and accordingly, show more self-oriented behaviour (e.g. higher level of attachment avoidance). The inconsistency between the hypotheses and the results can be explained in two aspects.

First, the self-orientation of the attachment avoidance is based on the mistrust of close others resulting from an infancy experience (e.g. Bartholemew & Horowitz, 1991). The impression of mistrust may last for life. And the resulting self-oriented social behaviours would solidify this impression by evading any more interactions with other people. Thereby, it is not necessary to relate to the internal focus of imagers. In contrast, the other-orientation of anxiously attached individuals is encouraged to over-attend to others' reactions and consequently they are always reinforced in the way they represent the world. For example, an anxious girl one day heard her friend said the dress she was wearing did not suit her. She was probably taking this seriously and checking all dresses in her wardrobe. And on following days, she attended more to her friend's comments on her dressing. The external focus and verbal coding of a verbaliser would reinforce this process (e.g. as a verbaliser, she is inclined to listen to others' suggestions and she is more sensitive to the implications of what others are saying, etc.). As a result, the influence of



the attachment anxiety and the verbal coding can be added up on social oriented behaviours.

Secondly, Riding and his colleague (1997; see Riding & Rayner, 1998) have reported that male imagers and female verbalisers were more likely to perceive the negative aspects of information. They concluded therefore that male imagers and female verbalisers were more pessimistic than male verbalisers and female imagers. This previous finding might explain the female-only effect found in the current study. For women, verbalisers are those who are sensitive to others' comments and tend to perceive information as negative. Thus the feedback is more likely to be negative concerning their perception of self which would further reinforce their attachment anxiety. Female imagers would have less chance to perceive such negative perceptions of the self and accordingly are less anxious. For men, the situation is reversed. Male verbalisers would explore more externally and seek outside feedback, but they would not treat the feedback as pessimistic as in the case of the female verbalisers. Whilst male imagers would be inclined to perceive information from outside as negative feedback, they are not as extroverted as verbalisers are. In sum, the gender  $\times$  style interaction makes the VI cognitive style show a zero effect on attachment anxiety for men.

#### *5.4.3 The Gender Differences*

In addition, besides the interaction with the VI cognitive style on attachment anxiety, gender was found an influential factor on empathy and the mirror (embodiment) task. Although these gender effects did not interact with cognitive styles, it is worthy to be mentioned.

Consistent with previous findings (e.g. Baron-Cohen et al., 2003; Baron-Cohen & Wheelwright, 2004; Lawrence et al., 2004), the present study replicated the female superiority on empathy. That is, overall women are more empathic than men in self-report.

However, interesting results were reported when dividing empathy into three components; cognitive empathy, affective empathy, and social skills. Men are not as inferior as it was thought in all empathic behaviours. Rather, they have the same level of ability as women to comprehend others' emotional states (i.e. cognitive empathy) and to apply rules into social judgements (i.e. social skills). The only difference is that men might be more inhibited from spontaneously responding to someone else' feelings, namely, the affective empathy. Such a finding is of value in considering the gender difference in future empathy research.

Moreover, women were reported to react significantly faster than men in the front-facing condition of mirror (embodiment) task, but not in the back-facing condition. The explanation of this interaction could be drawn from daily life experience. Women generally spend longer time in front of mirrors because of the social pressure of appearance concerns. Inferentially they are more skilful than men doing the front-facing mirror judgements.

## **5.5 Conclusions**

This chapter has investigated the effect of the WA and the VI cognitive style on self- or other-related processes with both behavioural and self-report measures. Accordingly, the WA cognitive style is argued to be associated with integrated body-related information rather than a disembodiment process. Wholists are advantageous in representing body-related information into a whole, and thus showed better performance in both the embodied/disembodied tasks. In contrast, the VI cognitive style demonstrated an effect on empathy in that imagers showed superiority in understanding and simultaneously responding to others' emotional states. It was argued this is attributed to the coding advantage of imagers in that they are able to hold a more detailed and vivid impression of



others' mental states. In addition, the female verbalisers appeared to be more anxiously attached to their partners than female imagers. Given the previous finding, it is suggested that this is caused by a co-effect of the external focus of verbalisers and the particular tendency to perceive the negative information of female verbalisers. However, caution must be drawn concerning those conclusions about the VI cognitive style. There are findings that have suggested the VI test of CSA is not a reliable measure as Riding has expected (see Chapter 1). And so its validity would be compromised. Is that true? The next chapter will work closely on this issue.

## **CHAPTER 6. THEORETICAL VALIDITY OF THE VERBAL-IMAGERY COGNITIVE STYLE**

The review in Chapter 1 clearly showed that the VI dimension has little support in terms of reliability and validity when compared to the WA dimension of cognitive style. Although the Dual Coding Theory (Paivio, 1971a) has provided strong theoretical support for the VI dimension and numerous educationalists have claimed successful applications of the VI style in educational practice (see Pearson, 2007; Riding & Rayner, 1998), its construct validity still needs to be confirmed. The contradiction between the advantageous theory application and the poor empirical examination of the construct compromises the research on the VI cognitive style. Thus, more experimental evidence is needed in this area; and this is the main focus of Chapter 6. In addition, given the poor reliability record of the VI test of CSA, there is confusion in the research of the VI style about whether the lack of validity results from the low level of reliability. To clarify this issue, an improved measurement of this dimension of cognitive style would be required, and the chapter attempts to do this.

This chapter is in three parts. First, an introduction to a revised test of the VI style - the Verbal-Imagery Cognitive Style test (VICS) - is presented with an improved reliability as a substitute for the VI test of CSA. Then, an investigation of the relationship between the VI cognitive style (measured by VICS) and several other individual difference constructs is covered. It aimed to establish the relationship between the (in-built) VI cognitive style and other psychological/physiological constructs, such as learning modalities, brain dominance, and handedness, in order to manifest its construct validity. However, no significant relationship was revealed. Finally, three cognitive tasks are employed to determine the theoretical hypothesis (i.e. the operational definition) of the VI



cognitive style by a priming paradigm. Hypothesised effects (according to the operational definition of the VI cognitive style) were not found. In sum, the results provided little evidence to support the construct validity of the VI cognitive style with current operational definition notwithstanding the confounding effect of the measure's reliability has been eliminated. It thus suggested a cautious re-consideration of the VI cognitive style itself.

## **6.1 Revision of the CSA: The VICS test**

### ***6.1.1 An Introduction to the VICS Test***

Concerns have been raised about the unsatisfactory reliability (see Chapter 1) of the VI test of CSA to determine VI cognitive style. This leads to a need to seek a substitute measure with improved reliability. However, the CSA did indicate that it had strong theoretical support and practical applications (e.g. Peterson et al., 2005a). To improve the test but still keep its advantages, Peterson and her colleagues (Peterson et al., 2003; 2005a) developed a new test of the VI cognitive style - VICS - on the basis of the CSA, which has addressed of the flaws of CSA outlined in Chapter 1. The main improvements will be discussed in turn (based on the Administration Guide of VICS; Peterson, 2005).

First, and most importantly the new test (VICS) modifies the stimulus questions. As participants might have confusion about whether two items are the 'same type' or the 'same colour', the questions in the VICS test have been designed to be more objective and culture-independent. Questions for participants include being presented with two objects and asked to judge if they are 'Natural' or 'Man-made' (verbal task) or which object is bigger in real life (imagery task). These two tasks keep the verbal and imagery nature, but provide further advantages in that the distinctions/similarity between the two objects become more significant.

Second, the VICS test uses the same stimuli in both the verbal and imagery tasks.

That is, a pair of objects is judged twice: once for size, once for being natural or man-made. This successfully solves the problem in the VI test of the CSA that the stimuli in the verbal and imagery tasks might not be well matched.

Third, the VICS test presents each stimulus in both picture and word form, so that both verbalisers and imagers have a chance to represent the stimuli in their preferred circumstance. And the result report provides more detailed information including participants' reaction time, correct answers, etc. to each question, which enables researchers to do potential in-depth analyses or exclude outlier data. Hence, researchers can calculate a ratio in a variety of ways, for example, verbal task in total with imagery task in total, verbal tasks in words with imagery task in pictures, etc. Moreover, the VICS test enables researchers to use the median reaction times to calculate the VI style ratio and this reduces the influence of any outliers.

Furthermore, practice phases have been added in the test to ensure that participants do know how to perform the tasks prior to the formal testing. And the VICS test has extended stimuli numbers to 232, which should be sufficiently increase reliability (Rezaei & Katz, 2004).

The VICS is a rather new measure for the VI cognitive style. However, there is experimental evidence that its internal consistency and test-re-test stability are satisfactorily high. For instance, authors of the test (e.g. Peterson et al., 2003; 2005a; 2005b) have reported the internal consistency of VICS was stably high ( $r > .72$ ) and the test-re-test reliability was more acceptable ( $r \approx .56$ ) compared to the original CSA test (i.e. internal consistency  $< .03$ ; test-re-test stability  $< .31$ ). Thus, it is considered to be a suitable substitute measure in this study to examine the validity of the VI dimension of cognitive style without considering the interference from the measure's poor reliability.

In addition, the internal consistency of the VICS test and its relation with the



original CSA test will be further examined in the first section of this chapter (6.1). The following hypotheses should be supported if the VICS test is an appropriate measure for the VI cognitive style:

H1. The VICS test should show a high split-half reliability in the present sample.

H2. The VICS test should show a correlation with the VI test of CSA because of its theoretical inheritance; however, the correlation might be moderate.

### *6.1.2 Method*

#### *6.1.2.1 Design*

A correlational design was used. The WA ratios and the VI ratios of CSA and the ratios from VICS test (including two split-half ratios) were treated as independent variables.

#### *6.1.2.2 Participants*

The 91 participants of the study were psychology students enrolled at the University of Bristol. All participants were native English speakers with no dyslexics. They took part in the study for the reward of course credit. Seventy-three of the participants were female. (Although the number of women in the sample is disproportionately high, it was argued to be acceptable. Riding (1997) consistently suggested that the cognitive style is independent from gender difference and previous studies (see Riding, 2005; plus all the samples within this thesis) have not found any significant gender difference with respect to the VI dimension of cognitive style.) The age of participants ranged from 17 to 44 years with a mean age of 20 years ( $SD = 4.31$  years).

#### *6.1.2.3 Materials*

Computerised versions of the VICS test (Peterson, 2005) and the CSA test (Riding, 2005) were used to determine participants' style ratios.

The VICS test contains new sections (verbal versus imagery), which include 232

stimuli in total (Rossion & Pourtois, 2001; Snodgrass & Vanderwart, 1980). The verbal and the imagery sections, which display the same items of stimuli, have different instructions of tasks. In the verbal section, participants are required to answer the category question “Are A and B natural?”. There are three possible responses to each question: “Yes”, “No”, or “Mixed” by pressing labelled number keys 1, 2, 3. The extra “Mixed” response, which was not included in the original CSA, is added to ensure that participants perceive both items (A and B) in each question in the verbal task. Otherwise, if the two items are always congruent (i.e. both natural or both man-made), participants may respond correctly by looking at only one and guessing the other. Feedback of correctness is given after each response. In the imagery section, participants are asked size questions: for example, “Is A bigger than B?” They are required to answer the question according to real sizes, as in the picture form the two objects are always presented as a similar size. There are also three possible answers: “Yes”, “No”, and (approximately) “Equal”. Feedback is given after responses. Accordingly, the “Equal” responses in the imagery task are designed to be consistent with the verbal task.

There are 58 different questions in each section (with only a few with a “Mixed” or “Equal” response). Each of them is presented in both a word form and a picture form. This solution is designed to fix the confounding effect that individuals with various VI styles might respond differently to picture and word based stimuli. Consequently, there were 116 questions in each section (verbal and imagery) and 232 questions in total. The presentation of stimuli is randomised within each test section.

Instruction is given before the testing of either the verbal or imagery section with example items (correct responses presented) and a practice session. The latter is an improvement to the CSA as it prevents participants from making mistakes or confounding delays occurring because of misunderstanding of the manipulation.



The reaction time and accuracy for each item are recorded. Similar to the CSA, the assumption underlying the test is that individuals always respond faster to their preferred ‘style’ of processing. Consequently, verbalisers will generally respond faster to the category questions in verbal-form than to the size questions in picture-form. In contrast, imagers perform in the opposite direction. By comparing the participant’s average reaction time on each task (verbal and imagery), a ratio that captures the person’s preference of the verbal or imagery representation of information can be calculated.

In addition, the VICS test has provided a variety of ways to investigate participants’ VI style of cognitive process. For example, ratios can be calculated in each stimulus form (words or pictures) by mean or median reaction times. However, the present study only uses an overall ratio (including all stimuli both in words and in pictures) for median reaction times to represent each participant’s position on the VI style preference continuum (Peterson et al., 2005a). The two additional split-half VICS ratios are also calculated by joint median reaction times based on both the word-form and picture-form stimuli.

#### *6.1.2.4 Procedures*

Participants were first tested by the CSA measure at the start of the test session. The VICS test was displayed after at least a one-hour gap (when they have completed some other tasks that will be presented in Section 6.2 and 6.3). Participants were not given any explanation about their cognitive styles until they had completed the final VICS test.

#### *6.1.3 Results*

The results of the two cognitive style measures are shown in Table 6.1. In order to examine the internal consistency of the VICS test, responses of the test were randomly split in half in each subsection (e.g. Natural, Mixed, Man-made – verbal task; Bigger, Equal, Smaller – imagery task). As a result, two more VICS ratios based on the split-half responses were calculated for each participant (namely, VICS\_i, VICS\_ii). The

correlations between the ratios are given in Table 6.1.

The internal consistency was reflected by the correlation between the split-half VICS ratios VICS\_i and VICS\_ii, which was consistently high with previous findings,  $r(91) = 0.758, p < .001$ . H1 was supported. In addition, both the split-half VICS ratios were highly correlated with the overall VICS ratios (i.e. both  $r > .84$ ), which further supported the test's internal reliability.

The VI ratios of CSA were significantly correlated with both the overall VICS ratios and the two split-half VICS ratios (all  $p < .05$ ), but the correlations themselves were moderate ( $r$  value ranges from .24 to .31). The finding was consistent with H2.

Table 6.1  
*Correlations between the style ratios with the means and standard deviations (SD) from two tests*

|         | Mean | SD   | WA-CSA | VI-CSA | VICS    | VICS_i   |
|---------|------|------|--------|--------|---------|----------|
| WA-CSA  | 1.22 | 0.37 |        |        |         |          |
| VI-CSA  | 1.04 | 0.12 | .055   |        |         |          |
| VICS    | 0.91 | 0.15 | .077   | .310** |         |          |
| VICS_i  | 0.94 | 0.18 | .074   | .295** | .863*** |          |
| VICS_ii | 0.87 | 0.16 | .113   | .242*  | .845*** | 0.758*** |

*Note.* WA-CSA = WA ratio of CSA; VI-CSA = VI ratio of CSA; VICS = overall ratio of VICS; VICS\_i, VICS\_ii = two split-half ratios of VICS

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$

In addition, all VICS ratios, either overall or split-half, stayed low and non-significantly correlated with the WA ratio (all  $p > .05$ ). This finding further testified Riding's (1997) claim of the independence between the WA and VI style dimension and supported the construct validity of the VICS test.

#### 6.1.4 Discussion

The first section of Chapter 6 introduced a newly developed measure of the VI cognitive style, which has improved a number of the design flaws that have been proposed in Chapter 1. The analyses indicated that the VICS test is highly internally consistent ( $r$



> .75) compared to the original VI test of CSA which showed a very poor internal consistency ( $r < .03$ ; Peterson et al., 2003). In addition, its moderate but significant correlation with the VI test of CSA and the low correlation with the WA test of CSA further establish the validity of this measure to some extent. Consequently, all these, combined with the previous studies of its satisfactory test-re-test reliability (e.g. Peterson et al., 2005a; 2005b), have made the VICS test a suitable substitute for the measure of the VI cognitive style since the possible confounding effect caused by the poor measure reliability could now be eliminated. Hence, the VICS ratios will represent participants' VI cognitive styles in the following analyses.

In the next two sections (6.2 and 6.3), questionnaires and behavioural tasks will be conducted to determine the construct validity of the VI cognitive style.

## **6.2 The Relationship between the VI Cognitive Style and Other Individual Difference Constructs**

### **6.2.1 Introduction**

In a recent survey of the definition of styles among researchers and experts, the cognitive style has been conceptualised as a kind of individual difference that exhibits the "...way of processing (perceiving, organising and analysing) information using cognitive brain-based mechanisms and structures..." and is "...partially fixed and relatively stable" (E. Peterson, S. Rayner, & S. Armstrong, personal communication, May 21, 2008).

Therefore, the cognitive style, in this case, the VI style, would be expected to have a relationship with other individual differences that are also linked to brain-based mechanisms. Section 6.2 includes three psychological/physiological indexes (learning modality, brain dominance, and handedness) in conjunction with the VI cognitive style in order to manifest such a relationship. Each will be described in turn.

### *6.2.1.1 Learning Modality*

Humans have five basic senses: vision, hearing, touch, smell, and taste. The term perceptual modality refers to the sensory channel via which input is received (Reiff, 1992). Among them, visual, auditory, and kinaesthetic are thought to be the three major sensory modalities during learning activities (Eislzer, 1983). Two surveys have shown that about 40% of children are visual modality dominant, 20-30% of children are auditory modality dominant, and the remaining 30-40% of children are kinaesthetic modality dominant (Dunn & Dunn, 1978; Haggart, 1995). There are few studies of the distribution of adults' dominant modality, but there is evidence that about half of the adult population have a preference for a predominant visual learning modality (Bell & Fogler, 1997; Kirby, Moore, & Schofield, 1988) and the majority of western students have been found to be visual modality dominant, too (Wallace, 1995).

Visual modality learners like shape, form, and images; while auditory learners prefer to hear someone's voice. The kinaesthetic modality can be divided into tactile and kinaesthetic channels; however, they were usually combined together in research (Grinder, 1989). Kinaesthetic learners have a desire to sense (e.g. position, movement, etc.) while tactile learners like to touch the materials. When the presented information is not in their preferred modality, people often try to transfer it. For instance, auditory learners may transfer visually presented information into auditory form by verbally describing it to themselves. Visual learners can transfer auditory information to visual format by conjuring images from the words (Pimentel & Teixeira, 1992).

There is a belief that learning will be enhanced if materials are presented in multiple modalities (Yates, 1966). For instance, Veenema and Gardner (1996) suggested that multimedia can facilitate learning by presenting information in both pictorial and textual manners. Some researchers have argued that the multi-modality input actually



increases the possibility that enables people to perceive information via their favoured modality channel (e.g. Riding & Ashmore, 1980; Riding & Douglass, 1993; Riding & Grimly, reported in Riding & Rayner, 1998). In other words, individuals have preferences of learning with a particular modality, similar to cognitive styles or learning styles (Fleming & Mills, 1992). When information is presented via multiple modalities, an individual can always choose information in a particular modality that matches his/her learning preferences and thus leads to an enhanced performance.

Although there is no official theory of perceptual modalities, it has been mentioned in the theory of Multiple Intelligences (Gardner, 1993). Currently, there are a number of different versions of learning modality questionnaire available for investigation. In the present study, the Barsch Learning Style Inventory (adapted from Barsch, 1991; see Appendix G) has been chosen for the identification of participants' dominant learning modalities.

Little research has been carried out to study the relationship between the VI cognitive style and learning modality preference. However, the general empiricist assumption suggests that mental processes retain the modality; that is, specific properties from the sensory channel via which information is derived would remain for following processes. The Dual Coding Theory (Paivio, 2007) has claimed a modality-specific nature of representation. That is, the main sensory channel by which the individual acquires information will affect the subsequent manner of information processing. Accordingly, one's favoured perceptual modality could be related to his/her preferred approach of information processing. For example, Riding and his colleagues have reported that generally imagers learn better from pictorial presentation while verbalisers learn better from verbal presentation (see Riding & Rayner, 1998). Therefore, an empirical relationship between one's dominant modality in learning and his/her preferred way of

information representation (i.e. the VI cognitive style) can be expected. (See Subsection 6.2.1.4 for corresponding hypotheses.)

#### *6.2.1.2 Brain Dominance*

Brain activity is another important index for the VI cognitive style. A review of the literature suggests that, after simplifying the concept, generally the left hemisphere of the brain is the location of verbal function whilst the right hemisphere is the location of imagery processing (see e.g. Bisiach & Berti, 1990; Borod, Bloom, Brickman, Nakhutina, & Curko, 2002; Gazzaniga, 1998; 2005; Geschwind & Miller, 2001; Langhinrichsen & Tucher, 1990; Riss, 1984). To be more precise, cognitive behaviours depend on the conjoint functioning of the left and right cerebral hemispheres (Hellige, 1993). That is, for performing a task, both brain hemispheres would make their respective contributions. However, significant asymmetries (brain dominance) exist within specific tasks. For instance, the left hemisphere is normally dominant for language and logical processing (e.g. mathematical and logical reasoning), whereas the right hemisphere is specified for emotion and spatial processing, such as shape recognition, spatial attention, musical and artistic functions, etc.

Numerous studies have revealed that performance on visual perceptual and spatial tasks can be selectively impaired following damage to the right cerebral hemisphere while the left hemisphere provides an overwhelming advantage for most linguistic tasks (see review in Paivio, 2007). Besides the differential effects caused by unilateral brain lesions, stimuli intentionally presented to the left or right hemisphere for neurologically normal individuals or commissurotomed patients lead to differing performance profiles (Hellige, 1993).

Based on this, Levy (1990) proposed that the verbal and the spatial performance can be predicted by measuring the balance of hemispheric activation. In line, Cohen (1982)



has hypothesised that individual differences in left-right brain electrical activity might be relevant to cognitive style differences. Riding, Glass, and Douglas (1993) reviewed several electroencephalogram (EEG) studies on verbal and imagery processing and concluded that the EEG alpha suppression during information processing was left hemisphere dominant for verbalisers and right hemisphere dominant for imagers.

Therefore, the VI cognitive style is asserted to be relevant to the left-right brain dominance with left-brain dominance for verbal individuals and right-brain dominance for imagery individuals.

#### *6.2.1.3 Handedness*

The assessment of handedness is a standard procedure in many neuropsychological related investigations of human behavioural asymmetries. It has been linked with lateralised functions in the brain for a long time.

Unlike many other individual differences, the distribution of handedness is an atypical J-shaped curve because of the majority of right-handers in the general population. Previous research has revealed that the left hemisphere controls movements of the right side of the body while the right hemisphere regulates movements of the left side of the body (Corballis, 2003). In the normal population, most humans (circa. 90%) are naturally more skilled with their right hand compared to the left hand (Sun & Walsh, 2006), which manifests a left-brain dominance. In contrast, non-humans have a fairly even distribution of the left- and right- handedness (see Annett, 1967). Such a unique asymmetric distribution of handedness in humans is suggested to be a result of a genetic basis emanating from a long history of evolution, but it is still thought to be somewhat susceptible to a cultural bias (Corballis, 1997). Annett (1998) proposed a 'right shift' theory to explain the human handedness asymmetry with an evolutionary perspective. She assumed that it results from an adaptively developed favour of the left cerebral hemisphere

in language activities; handedness is the secondary consequence of this development.

There is enormous experimental evidence to support Annett's postulation of handedness. For instance, left-handedness was found to increase the occurrence of right-hemisphere language dominance (Corballis, 2003). The previous section (6.2.1.2) has presented the general advantage of the left brain hemisphere in linguistic processing. However, the left hemisphere dominance in language exists in more than 95% of the right-handed population but in only 70% of the left-handed population (Corballis, 2003). Some recent studies (e.g. Knecht et al., 2000; Pujol, Deus, Losilla, & Capdevila, 1999) even suggested a linear relationship between the two indexes.

Congruent with Annett's (1998) theory, Paivio (2007) commented in his Dual Coding Theory that the verbal system is also a consequence of the requirement of language activities. Compared to the non-verbal system, the verbal system emerges much later during human evolution. Inferentially, modern humans are inclined to be more right-handed compared to non-humans because of the evolutionary emergence of the verbal system of coding (which was suggested to be located in the left cerebral hemisphere). Therefore, handedness must to some extent be related to the verbal system in a brain-based mechanism, and consequently, to the VI dimension of cognitive style. Thus it is proposed that verbalisers, who focus more on the verbal system of representation, are more likely to be right-handed. Imagers, in contrast, are less dependent on the verbal system of coding, are likely to be left-handed.

#### *6.2.1.4 Hypotheses*

According to the previous review, proposed relationships between the VI cognitive style and an individual's preferred learning modality, brain dominance, and handedness are as follows:

H3. Imagery individuals tend to be visual modality dominant as the visually input



information (containing more visual properties) might facilitate the following imagery mental representation during processing.

H4. Verbal individuals tend to be auditory modality dominant so that the information input and the information processing have the congruent verbal nature.

H5. Verbal individuals tend to exhibit left-brain dominance whilst imagery individuals tend to show right-brain dominance in self-reports.

H6. There will larger number of right-handers within verbalisers than within imagers, and will be larger number of left-handers within imagers than within verbalisers.

### *6.2.2 Method*

#### *6.2.2.1 Design*

This section of the study employed a between-subject design with the VI style groups (split based on the VICS ratios) as the independent variable. The dependent variables were participants' preferences of learning modality, brain dominance, and handedness.

#### *6.2.2.2 Participants*

The participants were the same as reported in Section 6.1 ( $n = 91$ ).

#### *6.2.2.3 Materials*

In this and following part of the study, participants' VI cognitive style was represented by their VICS ratio (Peterson, 2005).

Participants were also surveyed by three additional paper-and-pencil questionnaires of learning modality, brain dominance, and handedness.

The Barsch Learning Style Inventory (adapted from Barsch, 1991; see Appendix G) was employed to evaluate the degree to which an individual is predominantly visual, auditory, or kinaesthetic during learning activities. The inventory contains 24 statements of learning activities for which participants are required to report how often each of them

happens (by three options: often, sometimes, and seldom). Each “often” response values 5 points, “sometimes” response values 3 points, and “seldom” response values 1 point. The points are added up with the corresponding statements under each modality preference. The highest score, which is also the most frequent activity related modality, refers to an individual’s predominant learning modality.

The Brain-Dominance Inventory (original author unknown, revised by Davis, 1994; see Appendix H) examines the general individual difference in terms of which side of the brain one prefers for information processing. The questionnaire includes a series of 39 questions of one’s behaviours or attitudes with three possible responses (referring to a preference of left-brain processing, right-brain processing, or bi-lateral processing, respectively) to each question. Responses are scored for the choices of each side of the brain. Then, individuals can be classified into left- or right-brain dominant or whole brain dominant.

Handedness was assessed by the Edinburgh Handedness Inventory (Oldfield, 1971; see Appendix I). This is a preference-based questionnaire consisting of 12 items. It is the most popular measure of handedness in research with a well-established test-re-test reliability (Ransil & Schachter, 1994). The inventory scores from 0 (very left-handed) to 100 (very right-handed). Generally, those people scoring beyond 75 are grouped as right-handers while those scoring below 75 are grouped as non right-handers.

#### *6.2.2.4 Procedures*

Each participant was tested on the three paper-and-pencil questionnaires in a randomised order before the final VICS test. There was no time pressure for completing the questionnaires.

#### *6.2.2.5 Data Analysis*

Participants’ results for handedness, brain dominance and modality preference were



recorded and analysed in the form of counts and percentages. One-way ANOVAs and Chi-squared ( $\chi^2$ ) tests were performed to determine the significance of their relationship to the VI style groups.

6.2.3 Results

Individuals with differing VI cognitive style were categorised based on their median ratio of VICS test (0.902). Each Verbaliser had a VICS ratio of  $\leq 0.902$  while each imager had a VICS ratio of  $> 0.902$ .

The results for learning modality preferences were recorded and totals were calculated for each of the three modalities (see Table 6.2). It was obvious from visual inspection of the table that the means of each modality scores varied little with respect to the VI style groups. Three one-way ANOVAs were conducted on the scores of visual, auditory, and kinaesthetic modality preference with the VI groups as a between-subject factor. The result showed there was no difference between the VI groups to any of the modality scores, all  $p > .05$ .

Table 6.2  
*Mean scores ( $\pm$  standard deviations) of each modality for verbalisers and imagers*

|             | Visual     | Auditory   | Kinaesthetic |
|-------------|------------|------------|--------------|
| Verbalisers | 30 $\pm$ 4 | 23 $\pm$ 6 | 25 $\pm$ 5   |
| Imagers     | 30 $\pm$ 4 | 24 $\pm$ 5 | 24 $\pm$ 5   |
| Total       | 30 $\pm$ 4 | 24 $\pm$ 6 | 25 $\pm$ 5   |

An individual's dominant modality was decided according to in which modality, a participant's highest score was located. However, there were a few participants ( $n = 5$ ) who had more than one dominant modality (i.e. two or three modalities had equal highest scores). In these cases, they were randomly assigned into one of their dominant learning modalities in order to be analysed. The distribution of the sample is shown in Table 6.3. It exhibited a majority of visual dominant individuals in the sample (about 71%), which was

congruent with previous findings (Bell & Fogler, 1997; Dunn & Dunn, 1979). The Chi-squared ( $\chi^2$ ) test showed no difference of dominant modalities between the VI groups,  $\chi^2(2) = 0.004, p > .99$ .

Table 6.3

*Number and percentage of learning modality groups for verbalisers and imagers*

|             | Visual     | Auditory   | Kinaesthetic | Total     |
|-------------|------------|------------|--------------|-----------|
| Verbalisers | 33 (71.7%) | 7 (15.2%)  | 6 (13.0%)    | 46 (100%) |
| Imagers     | 32 (71.1%) | 7 (15.6%)  | 6 (13.3%)    | 45 (100%) |
| Total       | 65 (71.4%) | 14 (15.4%) | 12 (13.2%)   | 91 (100%) |

The distribution of participants' brain dominance (i.e. left-brain dominant, bi-lateral, and right-brain dominant) in conjunction with their VI style groups is shown in Table 6.4. Again, no significant difference was reported by the Chi-squared ( $\chi^2$ ) test between the VI groups of their brain dominance,  $\chi^2(2) = 0.934, p > .62$ .

Table 6.4

*Number and percentage of brain dominance groups for verbalisers and imagers*

|             | Left-brain Dominant | Bi-lateral | Right-brain Dominant | Total     |
|-------------|---------------------|------------|----------------------|-----------|
| Verbalisers | 26 (56.5%)          | 11 (23.9%) | 9 (19.6%)            | 46 (100%) |
| Imagers     | 21 (46.7%)          | 14 (31.1%) | 10 (22.2%)           | 45 (100%) |
| Total       | 47 (51.6%)          | 25 (27.5%) | 19 (20.9%)           | 91 (100%) |

Table 6.5

*Number and percentage of right- and left- handers for verbalisers and imagers*

|             | Left-handed | Right-handed | Total     |
|-------------|-------------|--------------|-----------|
| Verbalisers | 8 (17%)     | 38 (83%)     | 46 (100%) |
| Imagers     | 8 (18%)     | 37 (82%)     | 45 (100%) |
| Total       | 16 (18%)    | 75 (82%)     | 91 (100%) |

Participants were divided into left- and right-handed groups based on their handedness scores (i.e. left-handed  $\leq 75$ ; right-handed  $> 75$ ). Table 6.5 shows the distribution of the right- and left- handers within the VI groups. The Chi-squared ( $\chi^2$ ) test showed that there were no differences between verbalisers and imagers in their handedness



distributions,  $\chi^2 (1) = 0.002, p > .96$ .

#### 6.2.4 Discussion

The verbal and the imagery participants in the present study were revealed to have almost identical distributions on predominant learning modality, brain hemisphere dominance, and handedness. Those results were inconsistent with the hypotheses H3 to H6. It was expected that the verbalisers and imagers would exhibit different preferences on the three neuropsychological related individual differences, as the VI cognitive style may share some brain-based common mechanisms with them. Consequently, the results failed to provide positive support to the construct validity of the VI cognitive style although the confounding effect from the poor reliability of the measure (i.e. CSA) has been eliminated by introducing the new VICS test.

In addition, the restricted distribution of the VI style ratios of the present sample ( $0.91 \pm 0.15$ ; see Section 6.1) could be argued as being an important factor in the non-significant results. That is, the difference between the verbal style group and the imagery style group was too little to exhibit a decisive difference. Peterson (2005) has stated that those whose VI style ratios are between 0.8 and 1.0 probably have little or no style preference. Hence, these middle ranged participants, who were the majority of the study sample, probably inhibited the overall results from significant differences in predominant learning modality, brain hemisphere dominance, and handedness.

However, it should be noted that it is not only the study sample but also the standardised sample ( $n = 376$ , mainly university students), which had a rather centred range of VICS ratios ( $0.99 \pm 0.41$ ). Further, concerning the original CSA test (Riding, 2005), it was also found that the distribution of the VI ratios in a standardised sample ( $n = 999$ ) seemed much more suppressed than of the WA ratios (VI ratios  $1.06 \pm 0.20$  versus WA ratios  $1.25 \pm 0.45$ ). (Comparatively, the CSA-VI ratios from the present sample were

1.04  $\pm$  0.12.) Accordingly, it is concluded that the majority of the population (according to the standardisation samples) bear a tiny variation of the VI style preference. Thus it should be regarded as rather a phenomenon than a confounding effect. (This will be further discussed in Section 6.3.)

In the next section (6.3), three behaviour experiments are introduced to examine further the validity of the VI cognitive style.

### **6.3 The Effect of the VI Cognitive Style on Verbal/Imagery Priming Tasks**

#### ***6.3.1 Introduction***

In trying to establish whether a psychological construct exists, observed behaviours are the most important index; however, there has been rather a lack of this in the research on the VI cognitive style. This section aims to proffer experimental evidence for the validity of this dimension of cognitive style by using a priming paradigm.

In general, the VI cognitive style is about the preferences for the form and function of individual knowledge, either verbal or imagery. The Dual Coding Theory (Paivio, 1971a) has established dissociation between a verbal system, which deals directly with linguistic materials, and a non-verbal (imagery) system, which is specialised for non-linguistic objects and events. The systems are thought to be composed of internal representational units; respectively, logogens (verbal units) and imagens (imagery units). The most obvious distinction between the two modes of representations is that logogens (verbal representations) are language-like and imagens (imagery representations) are picture-like. Logogens include not only the forms of nature language, but also formal systems such as mathematics, symbolic logic, and computer language, etc. Imagens could include forms of photographs, drawings, maps, and diagrams etc. Verbal representations are characterised as being non-analogue, non-iconic, digital, or discrete, referentially



arbitrary, and propositional. While the features of imagery representations can be described as having analogue, iconic, continuous, and referentially isomorphic properties.

Paivio (1971b) further linked the Dual Coding Theory to the verbal-imagery individual differences. He developed the Individual Differences Questionnaire (IDQ) to profile individuals' ability, habits, and preferences for the verbal- or the imagery- system. IDQ employs a series of true/false questions to measure participants' preferences for information processing, verbal or imagery. The responses result in a single dimension with high scores reflecting imagery tendency and low scores reflecting verbal tendency. Here, Paivio implied a dominant-non-dominant relationship between the two coding systems, which is proposed to be reflected in individual differences.

Riding and Cheema (1991) signified the VI cognitive style based on Paivio's (1971a; 1971b) work. They summarised it as a marked tendency that an individual consistently uses one representational system more than the other. However, this definition of the VI cognitive style remains vague to some extent. Riding and his colleagues (e.g. Riding & Rayner, 1998) did not clearly explain the relationship between the two representational systems and how it manifests in the VI style. It is apparent that every well human has the two representational systems and s/he is capable of using either during information processing. But what exactly does a 'preferred' mode mean? Is it that the verbal and non-verbal systems compete with each other and the 'preferred' style refers to the consistent winner? Or are the two representational systems actually functionally independent but one is more explicit than the other at output? And so on. This question is crucial to answer in order to clarify the nature of the VI cognitive style.

There might be clues in its measurement; the VI test of CSA. The operational definition of the VI style (according to CSA and VICS) implies a *one-or-the-other* competing relationship between the verbal and imagery representations. The measure of

the VI cognitive style is based on the implicit assumption that in a given circumstance/task, only one of the two representing systems is activated. For example, an imager is defined by CSA as the person who responds faster to imagery questions than to verbal questions. In order to conclude this, the mean/median reaction time (either for the verbal or the imagery questions) must be a comprehensive representative of the speed of each representing process. That is, the individual *only* uses the imagery representations for the imagery questions and uses verbal representations for the verbal questions. Or, if both systems are activated for either questions, the VI reaction time ratio becomes meaningless.

It is necessary to investigate whether such an assumption holds. If not, the validity of the VI cognitive style (or at least, the current measure of it) collapses no matter how reliable the measure is. However, little work has been done on this issue. Section 6.3 aims to examine the assumption of a competing VI dimension of representation by three priming tasks with the identical paradigm. In each of the tasks, participants were primed by images or words prior to the target test (either of an imagery or verbal nature). Three common findings were expected based on the competing VI dimension assumption:

(a) One's preferred VI representational mode will enhance his/her performance on a congruent target task. For example, a verbaliser would respond generally faster than an imager in a lexical decision task as the word will be readily represented verbally; therefore, the comparison between the stimulus representation and the ones in a pre-existing lexicon is faster.

(b) The congruent prime-target stimuli will facilitate the response latencies whereas the incongruent prime-target stimuli will inhibit the responses. This is because in the incongruent situation the prime has evoked a conflicting representational system to the one of the target task, which would cause extra effort to reconcile. For example, an image prime would arouse imagery representing, which is conflicting with the following lexical



decision task. Therefore, there will be an inhibitory priming effect. In contrast, in the congruent situation the prime has pre-evoked the required representational system, and consequently saves time for the target task. A word prime would evoke the verbal coding system, which is consistent with the following lexical decision task. Hence, there will be a facilitating priming effect.

(c) The VI cognitive style and prime-target congruency will function corporately on one's performance of the task. In the prime-target incongruent condition, participants may have to spend more time to reconcile their representation from their preferred representation mode (e.g. aroused in prime phase) to their unpreferred one (e.g. required in target task). For instance, a verbaliser might need more effort to quit the verbal representing system aroused by a word prime to attend the following mental image rotation task. This is because in a competing VI representing continuum, a 'preferred' mode of representation should always refer to a more robust one (no matter verbal or imagery). Thus, it may need more effort to leave for another representing system.

In the following subsections, the three prime tasks will be discussed in more details.

#### *6.3.1.1 Mental Rotation Task*

Mental rotation refers to a cognitive process of mentally imagining an object as turning around (Shepard & Metzler, 1971). This process is understood to be implemented in the parietal cortex (e.g. Jordan, Heinze, Lutz, Kanowski, & Jancke, 2001) and suggested to heavily depend upon the imagery system. A typical task that employs a classic mental rotation procedure usually presents two stimuli (e.g. 3D-cube figures) with varied angular disparity, and measure the reaction time taken for participants to decide whether the two figures match or not. The cognitive process of the mental rotation task can be functionally divided into five phases. They are: 1) perceptual encoding of the stimuli; 2) mental rotation; 3) comparison; 4) decision making; and finally 5) response output. For the relationship

between these five phases of process, researchers have suggested that it is either strictly sequential (e.g. Stoffels, 1996) or only with very small overlap (e.g. Heil, 2002).

Given the present study, the interest is in the encoding phase of mental rotation in conjunction with the VI dimension of cognitive style. One's VI style determines his/her verbal versus imagery preference for information encoding/representation. For example, an imager would represent the figures more efficiently than a verbaliser as the stimuli match the form of his/her favourite representing mode. Consequently it could shorten the entire response time of the mental rotation process for the imager.

Furthermore, if the VI cognitive style refers to a single competing dimension with the verbal versus imagery representation, that is, if every time individuals tend to use only one mode of representation rather than another, then the mode of prime stimuli should affect the following process significantly. For instance, a pictorial prime will arouse the imagery coding in advance and shorten the following coding phase of image mental rotation. In contrast, a word prime will arouse the verbal coding system and interfere with the following (imagery) coding of stimulus figures.

In addition, one's VI cognitive style, which is a person's principal mode for representing (i.e. being consistently used for coding rather than the other), will probably affect the priming effect as well. The priming effect is caused by whether or not the representing mode should be switched from one to the other. And leaving the primary (i.e. preferred) mode of representation for the secondary (i.e. un-preferred) one must require more effort than leaving the secondary mode of representation for the primary one. In this task, verbalisers' performance of mental rotation should be affected more by the interference from the verbal primes.

#### *6.3.1.2 Lexical Decision Task*

The second task is a lexical decision task. It mainly emphasises visual word



recognition and focuses on the orthographic process. In this task, participants are asked to determine as quickly as possible whether a letter string is a word or a non-word. By this means, researchers are able to study the processes of word recognition, based on which reading process commences. The lexical decision task is a very popular tool in linguistic research and a large number of studies have been conducted using it. Currently, the process of lexical decision is generally agreed by the majority of models as a consecutive process according to the following.

First, the presented letter string activates the prior existent word representations in mind that are orthographically and/or phonologically similar to the presented letter string. Secondly, every match of features between the stimulus and the mental word representation provides a positive feedback. Finally, when the positive feedback exceeds a criterion value, a 'word' response was made; in contrast, not enough positive feedback leads to a 'non-word' response (the default response) (see the review of Jacobs & Grainger, 1994).

In this study, a lexical decision task is employed to address the impact of an individual's preferred mode of representation (VI style) on his/her ability in recognising words. To compare with pre-existent word representations, individuals need to code the stimulus words in a verbal mode. And verbalisers, who are more adept to verbal representation, should benefit during this process.

Similar to the mental rotation task, verbal or imagery primes will be presented prior to each trial of the lexical decision task. It is presumed that the type of the primes will either facilitate or interfere with the process of lexical decision because of the consistency/conflict between the representation of the prime stimuli and the representation of the lexical decision stimuli. However, in contrast to the mental rotation task, the lexical decision task is a task of a verbal nature and favours the word primes. Hereby the word

primes are expected to lead to faster responses in the lexical decision task.

Again, the priming effects are suggested to interact with participants' VI cognitive styles as the switch from the primary mode of representation to the secondary mode of representation must be more effortful than vice versa. Thus, imagers might face more difficulty than verbalisers during the image prime condition of lexical decision.

#### *6.3.1.3 Relatedness Judgement Task*

Reading is a complex process that involves activating many different types of information, such as orthographic (i.e. visual), phonological (i.e. sound), and semantic (i.e. meaning) information. The lexical decision task primarily invokes the orthographic process; yet it may be of interest to look at another component of language processes, namely, the semantic process. Although intuitively the semantic processing of a word (i.e. access to the meaning of the word) should happen after entire word recognition, there are debates that semantic information could be activated early in the recognition process (e.g. see Marslen-Wilson, 1987). However, this is not a question to be addressed in the thesis. Rather the aim is to investigate whether and how the semantic process (i.e. judgement of semantic relations between words) is influenced by the different types of primes and one's VI cognitive style.

In the third priming task, participants will be presented with word pairs and be required to judge if the words in each pair are semantically related. Semantic relatedness covers a range of relationships between words, including similarity/difference as well as other relations such as "is-a-kind-of", "is-a-part-of", "is-a-specific-example-of", and "is-the-opposite-of" (Budanitsky & Hirst, 2001). Humans usually are able to judge quickly the relative semantic relatedness between a pair of words/concepts. For example, most people would agree that *paper* is more related to *pencil* than it is to *dog*. This ability to assess the relatedness between words/concepts has an important application in language practice. For



instance, '*The interest rate of my bank is 5%.*' In this case, a reader would know the 'bank' refers to a financial institution rather than a river shore with reference of the related words 'interest' or 'rate'.

It is assumed that the semantic relatedness judgement of word pairs is verbally abstract in nature and especially requires verbal representations. Thus, verbalisers would make more speedy decisions than imagers as verbalisers are quicker in verbally coding the stimulus words and then facilitating the following processes (Riding & Rayner, 1998).

Consistent with the lexical decision task, the semantic relatedness judgement task is expected to be positively primed by the word primes, which are assumed to pre-evoke a verbal representation and facilitate the following semantic process. Whilst the image primes are expected to exhibit an inhibitory effect on the judgement because the incongruent imagery coding caused by image primes will interrupt the verbal representation of words and consequently interfere with the semantic judgement.

The final hypothesis of this task is concerned with the interaction between the priming effect and individuals' VI cognitive style. The inhibitory effect of the image primes is probably more significant in imagery individuals in respect that they find it more difficult to switch from their preferred imagery representation to the following verbal representation required in the semantic relatedness judgement.

#### *6.3.1.4 Hypotheses*

Based on the literature, nine experimental hypotheses were devised with respect to the three priming tasks. They are as follows:

##### *Mental Rotation Task*

H7. The imagery participants would show overall shorter reaction times than the verbal participants in the mental rotation task.

H8. The image primes will shorten the reaction times of mental rotation, and the

word primes will lengthen the reaction times of mental rotation.

H9. The negative priming effect of the word primes in the mental rotation task will be larger for verbalisers than imagers.

#### *Lexical Decision Task*

H10. The verbal participants would show overall shorter reaction times than the imagery participants in the lexical decision task.

H11. The word primes will speed the reaction times of the lexical decision and the image primes will slow the reaction times of the lexical decision.

H12. The negative priming effect of the image primes in the lexical decision task will be larger for imagers than for verbalisers.

#### *Relatedness Judgement Task*

H13. The verbal participants would show shorter reaction times than the imagery participants in the semantic relatedness judgement task.

H14. The word primes will shorten the reaction times of the relatedness judgement and the image primes will enlarge the reaction times of the relatedness judgement.

H15. The negative priming effect of the image primes in the semantic relatedness judgement task will be larger for imagers than verbalisers.

### *6.3.2 Method*

#### *6.3.2.1 Design*

The three priming tasks employed a similar  $2 \times 3$  mixed design paradigm with the VI cognitive style (verbalisers versus imagers) as the between-subject factor and prime type (word, image, and blank) as the within-subject factor. The dependent variables differed according to individual tasks.

*Mental Rotation Task.* The dependent variables for the mental rotation task were the reaction times and accuracy in identifying the figures (i.e. 'are the two figures the same



one?’’).

*Lexical Decision Task.* The dependent variable for the lexical decision task was the reaction times for participants to respond correctly to presented letter strings (i.e. whether words or a non-words).

*Relatedness Judgement Task.* The dependent variable for the semantic relatedness judgement task was the reaction latency in judging whether the words in each pair were semantically related.

More details of each task can be seen in Subsection 6.3.2.3 Materials.

### 6.3.2.2 Participants

The participants were the same as in Sections 6.1 and 6.2 (n=91).

### 6.3.2.3 Materials

The three priming tasks were designed and administrated using the commercial software SuperLab version 2.0 (Cedrus Corporation, 1999).

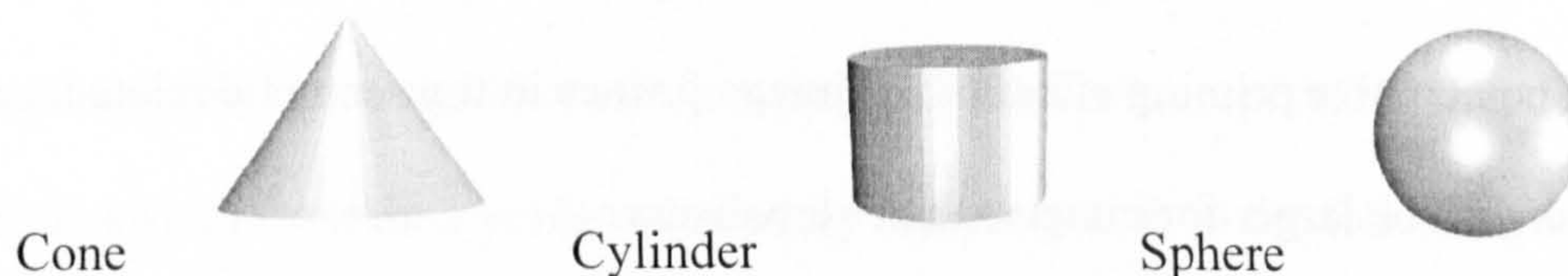


Figure 6.1. The image primes presented in priming tasks

There were three types of primes used in the tasks of this section; word, image, and blank. The word primes contained nine lowercase 5-letter words with three in each task. Their details will be stated individually for each task. All word primes were presented centrally in size 100 Arial font (bold) in black on a white background. The image primes were constant throughout all tasks and presented as an approximately 10cm × 10cm grey cone, cylinder, and sphere at the centre of the screen (see Figure 6.1). The blank prime was the control condition, in which participants were presented with nothing but a blank mask.



*Mental Rotation.* The stimuli used in the mental rotation task were modified from the classic Shepard-Metzler 3D- cube object (Shepard & Metzler, 1971). The object consisted of 10 cubes attached face-to-face to form an armlike structure (see Figure 6.2). Each cube had an apparent edge length of 1 cm.

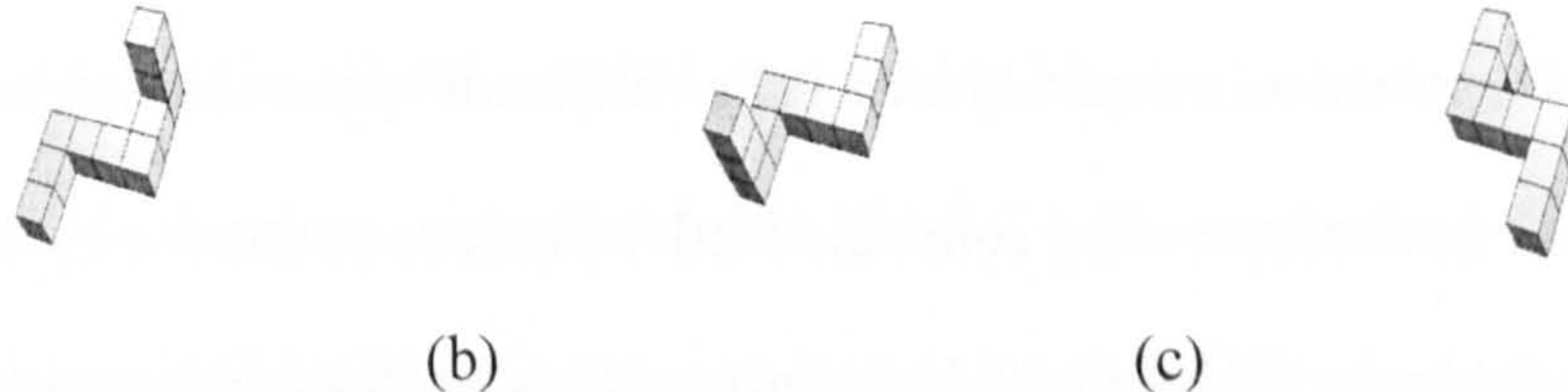


Figure 6.2. The three initial perspectives of the original object

A total of 88 stimuli figures were created by rotating the object and its mirror counterpart in  $45^\circ$  steps from a start perspective around an axis. There were three axes that were chosen for the construction of the stimuli: the horizontal x-axis, the vertical y-axis, and the depth z-axis. Three initial perspectives of the object were chosen as shown in Figure 6.2. It was noteworthy that the figural axes (through the object's mass centre) of the object differed  $10^\circ$  from the rotational axes (x, y, z). Whereas the perspective (a), (b), and (c) rotated  $180^\circ$  from each other through the figural axes, they would not superpose each other after rotating through one of the axes (x, y, z). For example, even (a) rotated  $180^\circ$  through z-axis, could not superpose (b). Rather, it offered a chance to produce more different perspectives of the object.

Accordingly, perspective (a) produced seven more stimuli figures by rotating the object around x-axis (via every  $45^\circ$  step), seven by rotating around y-axis, and seven by rotating around z-axis. Similarly, perspective (b) and (c) produced another 42 stimuli figures. In addition, a 'mirror' object was generated by mirror-reflecting the original object at perspective (a) (Figure 6.2) via y-z picture plane. Likewise, 21 more mirrored stimuli figures were created by rotating the 'mirror' object around x-, y-, z- axis. In sum, 88



stimuli figures were randomly presented with 44 pairs, in which 22 pairs contained congruent figures that the two could be rotated into congruence with each other (as in Figure 6.3, A), and 22 pairs contained different figures that the two differed by a reflection as well as a rotation and could not be rotated into congruence (as in Figure 6.3, B). For each pair participants were asked to decide whether the two figures were from the same object. The inclusion of the mirrored object for the “different” pairs was intended to prevent participants from discovering some distinctive features possessed by only one of the two objects and thereby reaching the incongruent decision without carrying out an actual mental rotation of the objects.

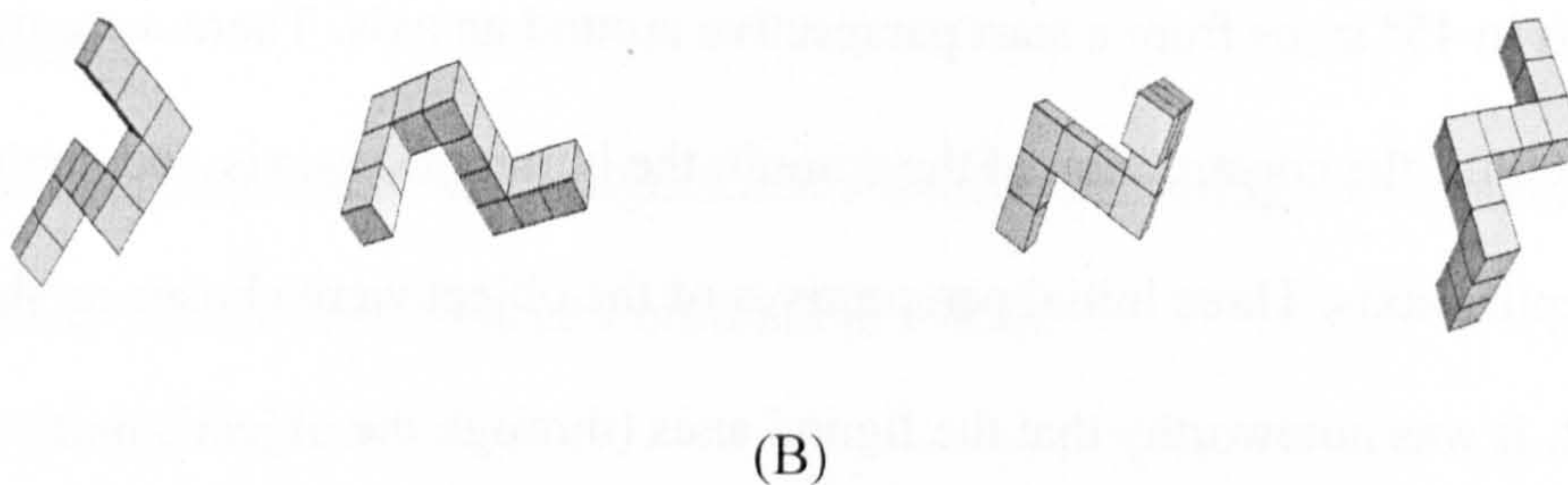


Figure 6.3. Examples of pairs of stimuli presented to participants. (A) a “same” pair; (B) a “different/mirrored” pair

The word primes included in the mental rotation task were specially chosen as low imageable (< 350) words (“claim”, “issue”, “reply”) that intended to avoid evoking the imagery representation with concrete (i.e. highly imageable) words (Paivio, 2007).

The overall session of the mental rotation task consisted of three blocks of 42 trials and one practice block of six trials, which resulted in a total 132 trials.

The practice block contained two pairs of stimuli with one “same” pair and one “different” pair, which were randomly repeated three times with an image prime (‘cylinder’), a word prime (‘does’), and a blank prime. In the practice block, the experimenter would survey whether the instruction had been fully understood and would clarify any possible questions. The practice block was excluded from data analysis.



Each test block contained all 42 pairs of stimuli, which were further divided into three sets of 14 stimulus pairs and counterbalanced between the blocks with the three prime conditions (see Table 6.6). Each of the three sets was in each prime condition (i.e. words, image, and blank) once across the three blocks. In sum, each stimulus pair was presented three times across the whole session that combined with all three prime conditions. For example, stimulus pair 1 appeared in block 1 with image prime, appeared in block 2 with blank prime, and appeared in block 3 with word prime. Trials within each block were randomised by the computer and participants had breaks between blocks. Consequently, participants did not see the same stimulus pairs but experienced all three prime conditions within one block. This was to prevent any possible confounding effect in case some stimulus pairs were more difficult than others, and hence interfere with the priming effect. Moreover, to avoid boredom effects, trials in block 1 were primed with image “cylinder” and word “reply”, trials in block 2 were primed with image “sphere” and word “issue”, and block 3 were primed with image “cone” and word “claim”. The order of the presentation of the three blocks was balanced across participants.

Table 6.6

*The allocation of the stimulus pairs (numbering 1-42) throughout the three blocks with prime conditions*

|         | Image Prime | Word Prime | Blank Prime |
|---------|-------------|------------|-------------|
| Block 1 | 1-14        | 15-28      | 29-42       |
| Block 2 | 15-28       | 29-42      | 1-14        |
| Block 3 | 29-42       | 1-14       | 15-28       |

*Lexical Decision.* Previous studies have found that there are several linguistic factors that would affect the lexical decision process. To eliminate possible confounding effects, they have been carefully controlled prior to the study. More details of the criteria used to select stimulus words can be found in Appendix J.

Generally, all stimulus words were four to six letter nouns with high written



frequency (> 25 per million) and familiarity (> 500). Any words, which did not have at least one neighbour and were morphologically complex, were discarded. The remaining words were matched for written frequency, familiarity, imageability, and Age of Acquisition (AoA) scores across the prime conditions.

Non-words were generated from changing a single letter in a group of words matched with the experimental word set (e.g. length) but without overlapping. All non-words were pronounceable and plausible, e.g. fine -> fune.

A total of 120 words and 120 non-words were used in this experimental task, with an extra three words and three non-words added in preceding practice trials (Stimulus words and non-words can be seen in Appendix J). Hence, a total of 246 stimuli were used in the overall experimental session. Target words (/non-words) were presented in size 66 bold Arial font in lowercase letters at the centre of the screen.

Consistent with the first mental rotation task, participants were primed at the beginning of each trial by images, or words, or blank pages. The image primes were identical with the ones used in the mental rotation task (see Figure 6.1), whilst the word primes were chosen as low imageable (< 350) 5-letter noun words (“dirge”, “melee”, “vista”), which did not appear in the target word stimuli.

This session of lexical decision task contained two blocks of 120 trials each and one practice block of 6 trials. The six trials of the practice block comprised three words and three non-words with each of them primed with the sphere (image prime), or word ‘kongo’ (word prime), or blank. So, participants could become familiar with the task prior to the formal testing. In each of the two test blocks, there were 20 words and 20 non-words that primed with word prime, 20 word and 20 non-word primed with image prime, and the rest 20 word and 20 non-word primed with blank. In the word-priming condition, each word/non-word was randomly combined with one of three prime words to avoid

boringness throughout the whole session. Similarly, in the image-priming condition each word/non-word was randomly combined with one of three prime images. Participants saw no word or non-word twice throughout the whole testing session. The stimulus words and non-words were randomly allocated to two blocks and the intention was to prevent participants becoming fatigued in completing all trials in one go. A break was located between the two blocks. The presentation of the trials was randomised within each block and the order of the two blocks was balanced across participants.

*Relatedness Judgement.* In the relatedness judgement task, 80 highly semantically related word pairs were employed. The word pairs were selected from Tyler, Moss, Galpin and Voice's (2002) study, which has empirically established the degree of semantic relatedness by creating 344 test word pairs and required 19 participants to relate each pairs on a scale from 1 (not related) to 9 (very strongly related in meaning). The mean value for each pair constituted its semantic relatedness score. To ensure that all word pairs were highly semantically related, any word pairs with a semantic relatedness score less than 5 were rejected. The average semantic relatedness score of the 80 word pairs were  $7.0 \pm 0.7$ . And the stimuli words ( $n=160$ ) were all 3-9 letter words (average  $5.34 \pm 1.31$  letters per word) with written frequencies  $44.72 \pm 75.33$  per million (Tyler et al., 2002).

In the present task, every semantically related word pair was further matched with a semantically unrelated word pair. Those semantically unrelated word pairs were obtained by pseudo-randomly rotating the original word pairs. That is, the word in one related pair was randomly paired with a word originally from another word pair. Half of the first word (located at left side of the word pairs) of the newly created unrelated word pairs changed their location (i.e. moved to the right side of the word pairs) and half of them remained the same location. Thus, participants saw each single word twice with different partner words (i.e. one was semantically related and the other was semantically unrelated). The method



ensured that the semantically unrelated word pairs were matched to the semantically related word pairs in terms of linguistic features such as familiarity, letter length, imageability etc. (The stimulus word pairs can be seen in Appendix K.)

The stimuli, either semantically related or unrelated word pairs, were presented in lowercase letter on the screen in Arial size 66. There were eight letter spaces and a “&” between the two words of each word pair (e.g. “origin & resource”).

The image primes in the task were identical with the other two prime tasks with cone, cylinder, and sphere (see Figure 6.1). The prime words (i.e. “pause”, “block”, “train”) were chosen based on the same criterion of low imageability (< 500), which did not appear in the target word pairs.

The total 160 word pairs (80 related and 80 unrelated) were randomly assigned into three prime conditions. There were 30 semantically related and 30 unrelated word pairs under the image prime condition; 10 related and 10 unrelated word pairs were assigned into each image prime (‘cone’/‘cylinder’/‘sphere’). Another 30 related and 30 unrelated word pairs were allocated to the word prime condition; 10 related and 10 unrelated stimuli with each word prime (‘pause’/‘block’/‘train’). The final 20 related and 20 unrelated word pairs were presented with a blank prime as the control condition. Accordingly, participants dealt with 160 trials in total. The trials were presented in two blocks. Each block contained half of the trials under every condition and stimuli were randomised inside each block. The order of the presentation of the two blocks was counterbalanced across participants. Participants were able to take a break between the two blocks.

An additional practice task was created to help participants becoming familiar with the task and responses. The practice task constituted of 12 trials with the word pairs that did not show in the main session. Six of the word pairs were semantically related and six were not. Participants also experienced an image prime condition with the cone, a word

prime condition with the word “guess”, and a blank prime condition.

#### *6.3.2.4 Procedure*

Participants were tested individually on the three priming tasks before the questionnaires (Section 6.2) and the final VICS test but after the CSA test.

The three priming tasks employed the same paradigm of procedures. On each trial of the tasks participants were first presented with a fixation cross in the middle of the screen for 500 ms, and then a prime appeared for 150 ms followed with 200 ms inter-stimulus interval. The target task (e.g. mental rotation, lexical decision, relatedness judgement) was displayed immediately after the interval and remained on the screen until a response was made. Trials proceeded continuously after responses were given.

Responses were given by pressing either blue dotted “N” button or the red dotted “B” button on the keyboard. Throughout the three tasks, a blue dot always referred to a “YES” response (e.g. the “same” object for the mental rotation task; “words” for lexical decision task; and “related word pairs” for relatedness judgement task), while a red dot always referred to a “NO” response (e.g. the “different” object; “non-words”; and “unrelated word pairs”). Those responses were consistent with the responses made in the CSA test, too, so that it reduced the systematic errors that participants might make by pressing the wrong button. The response times and accuracies were recoded for each task. No feedback was given to participants concerning the accuracy of their response during testing.

The order that participants received the three tasks was counterbalanced across participants.

#### *6.3.2.5 Data Analysis*

Concerning the two verbal tasks (i.e. lexical decision task and the relatedness judgement task), a biased distribution of stimulus words (i.e. with varied frequency, word



length, imageability scores, etc.) might confound task performances. To eliminate such a possibility, ANOVAs were carried out to examine if there were any statistical differences of stimulus words' linguistic characteristics across the experimental conditions for these two tasks.

Table 6.7  
*Linguistic statistics for the word stimuli used in the lexical decision task*

| Prime         | Frequency<br>Mean/SD | Familiarity<br>Mean/SD | Imageability<br>Mean/SD | AoA<br>Mean/SD | Number of<br>letters<br>Mean/SD |
|---------------|----------------------|------------------------|-------------------------|----------------|---------------------------------|
| Image (n=40)  | 126/153              | 549/39                 | 326/77                  | 363/59         | 4.72/0.8                        |
| Word (n=40)   | 137/160              | 565/34                 | 328/75                  | 340/55         | 4.88/0.9                        |
| Blank (n=40)  | 128/266              | 559/38                 | 331/74                  | 349/59         | 4.80/0.8                        |
| Total (n=120) | 130/199              | 558/37                 | 328/75                  | 350/58         | 4.80/0.8                        |

Written frequency, familiarity, imageability and AoA scores as well as the word length of the stimulus words used in the lexical decision task were shown in Table 6.7. Five one-way ANOVAs were carried out to see if those linguistic characteristics were matched across the three prime conditions (blank, word, and image). No statistical differences were found in the frequency ( $F(2,117) = 0.038, p = .963$ ), familiarity ( $F(2,117) = 1.756, p = .177$ ), imageability ( $F(2,117) = 0.041, p = .960$ ), and AoA scores ( $F(2,117) = 1.556, p = .215$ ) as well as the number of letters ( $F(2,117) = 0.326, p = .722$ ).

Table 6.8  
*The average word length and written frequencies (with standard deviation in bracket) for word stimuli used in the relatedness judgement task*

|                      | Related Word Pairs |                  |                  | Unrelated Word Pairs |                  |                  |
|----------------------|--------------------|------------------|------------------|----------------------|------------------|------------------|
|                      | Image<br>(n=60)    | Word<br>(n=60)   | Blank<br>(n=40)  | Image<br>(n=60)      | Word<br>(n=60)   | Blank<br>(n=40)  |
| Word<br>length       | 47.06<br>(79.77)   | 43.49<br>(82.08) | 43.04<br>(57.47) | 49.06<br>(90.82)     | 49.96<br>(79.10) | 30.35<br>(30.13) |
| Written<br>frequency | 5.30<br>(1.28)     | 5.42<br>(1.12)   | 5.30<br>(1.60)   | 5.33<br>(1.39)       | 5.35<br>(1.33)   | 5.35<br>(1.19)   |

Two more one-way ANOVAs were raised to examine if there were any statistical differences of word length and frequency of the stimulus words across the experimental

conditions in the relatedness judgement task. No significant differences were found for either related or unrelated word pairs, both  $F(2, 157) < 1, p > .05$ . See Table 6.8.

Thus it can be concluded that stimuli were well matched throughout the three prime conditions for both the lexical decision and the relatedness judgement task. And it should not bring relevant confounding effects for the final findings.

6.3.3 Results

6.3.3.1 The VICS Style Groups

The grouping of the VI style was identical with Section 6.2. Participants were divided into two groups based on the median (0.902) of their VICS ratios and consequently there were 46 in the verbal style group and 45 in the imagery style group.

6.3.3.2 Mental Rotation Task

The reaction times from the correct responses and the accuracies were recorded from the mental rotation task. They were analysed separately.

Reaction times of 17 participants were excluded from the analysis for this task because of a low number of correct responses (< 60%). See Table 6.9 for descriptive statistics of remaining data.

Table 6.9  
*The descriptive statistics (mean ± standard deviation) of reaction times (ms) for three prime conditions within each VI group in the mental rotation task*

| RTs            | Image        | Blank        | Word         |
|----------------|--------------|--------------|--------------|
| Verbal (n=35)  | 11051 ± 3848 | 11079 ± 3704 | 11106 ± 4024 |
| Imagery (n=39) | 11155 ± 3809 | 11079 ± 3713 | 10921 ± 3635 |

A two-factor mixed ANOVA with prime condition (word, image, and blank) as the within-subject factor and the VI group (verbal versus imagery) as the between-subject factor, was conducted on the response latencies of the mental rotation task. No significant main effects were found for prime ( $F(2, 144) = 0.177, p > .80, \eta_p^2 = 0.002$ ) or VI group ( $F(1, 72) = 0.001, p > .97, \eta_p^2 = 0.000$ ). The prime × VI group interaction was not significant



either ( $F(2, 144) = 0.440, p > .61, \eta_p^2 = 0.006$ ).

Table 6.10  
*The descriptive statistics (mean  $\pm$  standard deviation) of the number of correct responses for three prime conditions within each VI group in the mental rotation task*

| No. of correct responses (out of 42) | Image            | Blank            | Word             |
|--------------------------------------|------------------|------------------|------------------|
| Verbal (n=46)                        | 31.54 $\pm$ 7.39 | 31.17 $\pm$ 6.78 | 31.83 $\pm$ 6.59 |
| Imagery (n=45)                       | 31.51 $\pm$ 5.95 | 31.27 $\pm$ 6.16 | 31.29 $\pm$ 6.33 |

A similar two-factor ANOVA was conducted on the number of correct responses of the mental rotation task (including all participants). And similar results were revealed.

Neither the prime condition ( $F(2, 178) = 0.497, p > .60, \eta_p^2 = 0.006$ ) nor the VI group ( $F(2, 89) = 0.015, p > .90, \eta_p^2 = 0.000$ ) showed a main effect. Their interaction also failed to reach significance,  $F(2, 144) = 0.397, p > .67, \eta_p^2 = 0.004$  (see Table 6.10).

6.3.3.3 Lexical Decision Task

Table 6.11  
*The descriptive statistics (mean  $\pm$  standard deviation) of the reaction times (ms) for three prime conditions within each VI group in the lexical decision task*

| RTs            | Image         | Blank         | Word          |
|----------------|---------------|---------------|---------------|
| Verbal (n=45)  | 749 $\pm$ 235 | 751 $\pm$ 228 | 741 $\pm$ 226 |
| Imagery (n=45) | 694 $\pm$ 129 | 711 $\pm$ 131 | 713 $\pm$ 139 |

As non-words were thought to be processed differently from familiar words (Weeks, 1997) the analysis of the lexical decision task included word stimuli only to avoid relevant confusion. The response latencies of word stimuli were recorded. Before data analysis, outlier responses with reaction times under 250 ms or over 1500 ms together with incorrect responses were discounted. One participant was excluded from the analysis of the task because of an extremely high error rate of responses. (Based on the raw data, this participant was suspected to be responding constantly ‘non-word’ to most of the stimuli.) Descriptive statistics of the remaining participants can be seen in Table 6.11.

A two-factor mixed ANOVA with prime condition (word, image, and blank) as the

within-subject factor and the VI group (verbal versus imagery) as the between-subject factor, was employed on the response latencies of the lexical decision task. Likewise, there was no main effect of prime conditions ( $F(2, 176) = 0.581, p > .54, \eta_p^2 = 0.007$ ) and no main effect of VI group ( $F(1, 88) = 1.158, p > .28, \eta_p^2 = 0.013$ ). The prime  $\times$  VI group interaction failed to reach significance,  $F(2, 176) = 1.168, p = .31, \eta_p^2 = 0.013$ .

#### 6.3.3.4 Relatedness Judgement Task

The incongruent responses in the relatedness judgement task (e.g. respond ‘unrelated’ to presumptive related word pair or vice versa) were discarded to prevent a possible confounding effect. No participants were excluded since they all performed with high correct rates ( $> 70\%$ ). The descriptive statistics are reported in Table 6.12.

Table 6.12

*The descriptive statistics (mean  $\pm$  standard deviation) of the reaction times (ms) for three prime conditions within each VI group in the relatedness judgement task*

| RTs (ms)       | Image          | Blank          | Word           |
|----------------|----------------|----------------|----------------|
| Verbal (n=46)  | 1608 $\pm$ 581 | 1515 $\pm$ 490 | 1597 $\pm$ 530 |
| Imagery (n=45) | 1610 $\pm$ 386 | 1545 $\pm$ 365 | 1648 $\pm$ 397 |

A two-factor mixed ANOVA with prime condition (word, image, and blank) as the within-subject factor and the VI group (verbal versus imagery) as the between-subject factor, was conducted on the mean reaction times of relatedness judgement based on all items. Different from the results of mental rotation task or lexical decision task, prime condition did have a significant main effect at semantic relatedness judging speed ( $F(2, 178) = 17.162, p < .001, \eta_p^2 = 0.162$ ) but as before, the VI group remained non-significant ( $F(1, 89) = 0.083, p > .77, \eta_p^2 = 0.001$ ). There was no significant prime  $\times$  VI group interaction found,  $F(2, 178) = 1.011, p > .35, \eta_p^2 = 0.011$ . Post hoc analyses of the significant prime condition were conducted by three paired t-tests, which compared all



three pairs of means<sup>‡</sup>. They revealed that participants responded significantly faster in the blank prime condition than either in the image prime condition ( $t(90) = 3.515, p < .003$ ) or in the word prime condition ( $t(90) = 5.037, p < .003$ ). No difference was found between the image and the word prime condition,  $t(90) = 2.226, p > .0167$ .

#### 6.3.3.5 Further Analysis

In order to determine whether the non-significant effects were resulting from ill group division, individuals were further grouped into three classical style groups (verbalisers, bimodals, and imagers; Riding, 1991) and all the analyses repeated. However, the results did not differ. Hence the two-group division remains for discussion.

#### 6.3.4 Discussion

The three priming tasks, although varied in their nature from imagery to verbal, showed no effect from the VI cognitive style or its interaction with the prime conditions. Neither of the types of prime had an effect on the target tasks as predicted; the only significant result concerned the relatedness judgement task. However, it was merely found that blank primes facilitated the overall semantic judgement compared to the other two types of prime, which left little relevance to the present discussion. (The hypotheses were interested in the difference between the image prime condition and the word prime condition.) The general non-significant findings throughout the three priming tasks did not corroborate Riding's assumption of the VI cognitive style of a competing relationship of the two representing systems.

These findings may signify more challenges to the validity of the (present) VI cognitive style. The current operational definition of the VI style (Peterson, 2005; Riding, 2005) encapsulates the concept of a single competing dimension between the verbal and

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<sup>‡</sup> There is an argument that the post hoc tests are not appropriate for significant related factors (Field, 2003). Thus the current analyses applied paired t-test instead of a post hoc test with Bonferroni correction to the  $p$  values. The correction is achieved by dividing acceptance  $p$  values (0.05; 0.01) by the number of t-tests conducted (Field, 2003). In this case, the significance level would be  $0.05/3 = 0.0167$ , and  $0.01/3 = 0.003$ , respectively.

the imagery representation systems. That is, every time only one of the two representing systems will be activated (an “*either one or the other*” relationship) rather than activating two independently and mutually functioning systems (a “*both*” relationship). If this is true, the results would be expected to show significant effects of priming, VI style and their interaction (see introduction 6.3.1), which was not found in the present study. In addition, since all three tasks have revealed consistent results, it is less possible to attribute the insignificant findings to the methodology flaws of any single task (e.g. stimulus materials, task question design, etc.).

The centred-range VICS ratios of the study sample might have an effect on the overall non-significant results. However, as has been discussed in Section 6.2, it is the entire population that shows a narrow distribution of the VI style ratios. Hence it rather propounds a new question to the validity of the VI cognitive style; how can a ‘style’ be valid if most people only show little of it?

Paivio (2007) has been successful in establishing two distinct mental subsystems of representing, which is a solid basis for the VI cognitive style. However, different from Riding’s (1991) belief, Paivio (2007) has propositioned a co-operative relationship between the two representing systems (verbal and imagery) in that both systems are generally involved in most activities. The examples even include language phenomena. The verbal representing system is necessary for linguistic information, but usually not sufficient. The imagery system could, more or less, complement the information input with rich knowledge and potential rules (see Paivio, 2007). The most significant evidence for this assertion is the concreteness advantage of memory (e.g. Begg, 1972; Paivio, 1967; 1975; Paivio & Csapo, 1973). Memory performance was generally found to be much better (i.e. it could be twice as good) in concrete materials (e.g. words, sentences, long passages) than in abstract materials. The most direct explanation of this is that verbal and non-verbal



systems encode information co-operatively. The concrete stimuli may activate both the verbal and non-verbal representations, where the two systems are functioning independently. Therefore, they have an additive effect on the memory trace. In contrast, the abstract stimuli are difficult to image and hence are likely to activate merely the verbal representations. As a result, the memory trace will be shallower than dually coded concrete stimuli. Paivio (2007) believed that cognition results from the interaction between the two coding systems. The verbal system dominates in some tasks and the non-verbal imagery system dominates in others. Accordingly, there is little chance for an *either-one-or-the-other* coding but a *dual-code* processing for most material input.

Hereby, the VICS test became invalid, at least at an operational level, despite its satisfactory reliability. Whereas the question “Are A and B natural?” is assumed verbal nature in semantic level, both the verbal and the imagery coding systems are aroused when participants undertook the questions. It is because in the VICS test the words were all selected as highly imageable ones in order to match the stimuli used in the verbal questions and in the imagery questions (CSA also does this). Thus, the dual coding effect is unavoidable when representing those stimulus words. Consequently, the reaction latency to the question is no longer a good indicator of the representing efficiency of a single representing system. Even though choosing only picture-form questions for the imagery task, the responses could be confounded. Paivio and Csapo (1969) found that the dual-code effect automatically occurred that pictures tend to be silently named and concrete words are imaged when participants have enough time and resource. It may happen in the VICS/CSA test as participants were told to take their own pace for the questions. It could also explain the central-distributed ratios of the VICS/CSA test.

At a base level, to validate the measure, the stimuli used in the tasks need to be strictly controlled. Such as, abstract words only for the verbal task with a word-form and

picture-form only for the imagery task, and in addition with a time pressure. However, it may be not enough to re-build the validity of the VI cognitive style with the face-value modification. Is the reaction time ratio (from two “pure” verbal/imagery tasks) a meaningful indicator of the VI cognitive style? It is possible that there are pure verbal tasks and rare pure imagery tasks, so that when performing them only one coding system is activated. Hence the reaction time ratios based on these tasks can be argued valid. However, individuals inter-work between the two systems in most realistic tasks. This kind of ‘VI cognitive style’ might have little ecological validity.

Otherwise, to measure this VI style as a preference (or dominance) between the two representing systems seems to have a better face validity (e.g. IDQ by Paivio, 1971b). A subjective self-report can tell directly whether and how much an individual likes to, or tends to, deal with pictorial or textual materials whereas the underlying two coding systems are both involved in the activities. Although such a measure might be influenced by social desire or personal experience etc., it could have a better ecological validity.

Besides these suggestions for modifications of the measure of the VI style, it is probably time to re-consider the basic definition of it. Riding and Cheema (1991) conceptualised the VI cognitive style as a stable preference of representing information, either verbally or imagery, although individuals obviously have capability to use either mode. Based on the earlier discussion, there could be a conscious preference between the two representing systems; however, the choice of which of the two systems dominate or how the two systems are to interact is heavily dependent on the given circumstance.

Cognitive styles are assumed to be partially fixed and relatively situation independent (E. Peterson, S. Rayner, & S. Armstrong, personal communication, May 21, 2008).

Comparatively, the VI style here seemingly coincides more with the definition of a malleable ‘learning style’ that one’s preferred way of responding to information according



to the environment or context (E. Peterson, S. Rayner, & S. Armstrong, personal communication, May 21, 2008). It is hard to imagine any individual reporting that s/he constantly uses only one mode of representation (e.g. verbal or imagery) in all environments. Certainly, more evidence is needed.

In addition, it might be worthy to raise a little more discussion of the population validity of the VI cognitive style. As has been mentioned earlier, the VI style has gained a very successful application in classroom practice especially for younger pupils, which seems to contradict the present finding of its poor (theoretical) construct validity. However the evolutionary perspective of the Dual Coding Theory might have provided a sensible explanation. Paivio (2007) regarded the non-verbal system as a primeval 'root' in the evolution of the human mind, which is the basement of the emergence of the verbal system. Consequently, a dual coding system leads to human intellect and achievement. Likewise, the early development of the non-verbal system of infants is fundamental for the later development of the verbal system. In short, the non-verbal system is accomplished earlier during child development while the verbal system is accomplished at a much later stage. The young children who have been categorised to be imagers are probably those who did not yet accomplish their verbal system so that they respond slower to the verbal questions (but not necessarily faster to the imagery questions compared to their peers). Although both the verbal questions and the imagery questions of CSA/VICS would involve the activities of both systems, the not well-developed verbal system is likely to affect the responses more of verbal questions (as the verbal system presumably dominates more in the verbal questions) compared to those of imagery questions. The modern education systems in western countries emphasise the primacy of language practice. Thus, those children who have not accomplished their development of the verbal system are presumably disadvantaged in the classroom. However, by providing them with

complementary presentation of pictorial or multimedia mode/s of learning materials, their learning achievements can be restored (e.g. Riding & Ashmore, 1980; Riding & Douglas, 1993; Riding & Grimley, see Riding & Rayner, 1998). Hereby, the success in the classrooms could be attributed to the detection of those students with late developed verbal systems rather than the successful application of the 'VI cognitive style'.

The final part of the discussion is to address a couple of possible experimental flaws of the study. The disproportionately high number of female participants recruited in the study might be criticised as a confounding factor of the behavioural data. Whereas some researchers have postulated that females usually outperform males on measures of verbal fluency, and males outperform females on tasks concern spatial ability (e.g. Halpern, 1992), the empirical reality of such a claim is still under debate. For example, men's superiority of mental rotation tasks mostly manifests on those accuracy-based paper-and-pencil tests (Voyer, Voyer, & Bryden, 1995); however, it is seldom found on mental rotation reaction times (see Heil & Jansen-Osmann, 2008). Recent studies with the Shepard-Metzler 3D- cube figures (which were used in the present mental rotation task) did not demonstrate any reliable gender differences in mental rotation speed (e.g. Peters, 2005; Voyer et al., 2006). Jansen-Osmann and Heil (2007) revealed that with various types of stimuli and well-matched samples, the gender difference in mental rotation reaction times is exhibited in polygon stimuli only, but not in 3D-cube stimuli. The mental rotation task in the present study employed 3D-cube figures as stimulus materials and reaction times as measurements, and accordingly is argued to be gender-bias free. Likewise, no specific evidence about the gender-bias was reported in the lexical decision and semantic judgement tasks.

Another concern of the experimental design, which might be raised, is the prime presentation. Each trial of the experiments presented the prime stimulus (image or word)



for only 150 ms. Although pilot research has proven that it was visible and identifiable, participants may have ignored them by intentionally attending to the target tasks (they may do it because they know it was irrelevant to their experimental performance). Fortunately, the significant prime effect found in the relatedness judgement task (although not in the direction that has been expected) may have testified to the effectiveness of the prime conditions. However, it still could not be certain if participants perceived image and word primes to a similar degree (i.e. whether the verbal and non-verbal systems coded the prime stimuli into a similar level). In future studies, the design of priming experiments should include an examination about whether the primes have been thoroughly perceived. For example, a simple post-study recognition task can be employed; "Have you seen this image/word during the experiment?" By this extra measure, an index of how well the prime stimuli have been perceived can then be empirically analysed.

In summary, by keeping possible experimental flaws in mind, the three behavioural priming tasks have provided challenging evidence to the current operational definition of the VI cognitive style. Experiment results did not support a competing relationship between the verbal and imagery systems of representation; rather, they implied a mutually functioning relationship between the two coding systems. Thereby, the theoretical basis of the VI cognitive style requires serious review before extending its applications into practice.

## **6.4 Conclusions**

The VICS test has been examined as a more reliable measure for the VI cognitive style compared to the original CSA test. However, it still demonstrated poor correlation with other individual differences, which were assumed to share some common brain-based mechanisms with the VI style. Moreover, the three priming tasks have provided

incongruent findings to the current operational definition of the VI cognitive style with an *either-one-or-the-other* assumption between the verbal and imagery representing systems. All these have raised concerns about the theoretical basis of the VI cognitive style itself. It is suggested that there could be a co-operative relationship between the two coding systems rather than a competing relationship as Riding (1997) has implied in the CSA. In this case, it is necessary at present to reconsider the understanding of this dimension of style. For instance, is it still sensible to use the reaction time ratio to indicate one's VI style? And is it appropriate to classify the VI style as a 'cognitive style' rather than a 'learning style'? It is important to clarify all these questions in order to develop our understanding of cognitive styles.



## **CHAPTER 7. GENERAL DISCUSSION AND CONCLUSIONS**

### **7.1 Summary of Experimental Chapters**

Individuals' consistent tendencies in the way in which they process information have been marked as cognitive styles (Tennant, 1988). The principle aim of this thesis is to elucidate the nature of two cognitive style dimensions, namely the WA and the VI style. Experimental evidence was provided to facilitate the understanding of their underlying mechanisms and to examine their construct validity.

As noted in Chapter 1, two distinct dimensions have been identified based on the cognition-centred style research by Riding and Cheema (1991). The WA cognitive style is thought to concern the organisation of processing and whether the input information tends to be viewed holistically or in parts. The VI cognitive style emphasises the coding process of information and whether individuals prefer to represent information pictorially or verbally. Riding and his colleagues (see Riding, 1997; Riding & Rayner, 1998) reported numerous studies to purport the construct validity of this two-dimensional cognitive style model. However, questions remain concerning the reliability and validity of the measure of the VI dimension, and more experimental evidence is needed to clarify the underlying mechanism of those style dimensions. Given these concerns, six studies (presented in Chapters 2 to 6) were conducted to address some of the research questions concerning the nature of cognitive styles.

Chapter 2 examined empirical relationships between the two cognitive style dimensions and their family relatives (i.e. those constructs that theoretically feature either style dimensions). This investigation provided further positive support for the validity of the WA cognitive style by demonstrating its significant relationship with its origin, the FDI cognitive style. In addition, the limitations of the GEFT (i.e. measure of FDI style)

were discussed, which might help to clarify previous controversial findings and the current moderate correlation between the two constructs. Moreover, the WA cognitive style was also found to relate to individuals' preferences of learning activities. Wholists are more inclined to "feel" than analytics during experiential learning (CE scores of LSI; Kolb & Kolb, 2005). The latter finding can be regarded as an influence from the WA cognitive style, which is assumed to be located at a root level of individual differences, to a superstructured information processing level (Curry, 1983; see Chapter 1). A restricted variety of the VI family members in earlier research made it impossible to select a reliable and valid index (as the FDI cognitive style to the WA dimension) for the VI dimension. But the significant relationship that was revealed between it and the concrete-abstract dimension of LSI (ACCE; Kolb & Kolb, 2005) provides indirect support for its construct validity also. Like the WA cognitive style, the VI cognitive style was suggested to locate at the innermost layer of the onion-shaped model of individual differences (Curry, 1983; Riding, 1997). Thus, its relationship with the concrete-abstract dimension of learning preferences is rather a projection from the underlying process to a more behavioural/habitual level. An individual's favoured coding manner, either picture-like or language-like, does affect his/her preferred type of learning materials, either concrete or abstract. This hypothesis was confirmed and it added positive weight to the validity of the VI cognitive style.

Chapter 3 and 4 focused on the WA cognitive style related processes and aimed to extend comprehension of its nature. Chapter 3 presented two experiments with the hypothesis that an attentional control function is reflected in the WA cognitive style.

In the first experiment, an attempt was made to vary the attentional-control difficulty for a metalinguistic task for second language speakers. It was achieved by presenting a list of short English texts with contexts being manipulated to be either normal



or absurd. Participants were then asked to find both grammatical and orthographic mistakes contained in texts. In this way, a higher level of attentional control ability was required for the absurd contexts to perform tasks as participants had to fix their attention to grammars and spellings of the language but ignore any influence from meaning. For second language speakers, the analytics performed significantly better (i.e. more grammar corrections) than the wholists in the high-attentional-control condition. The difference between the WA style groups was less distinct for the control condition. Interpreting this finding in conjunction with a previous study (e.g. Bialystok, 1992), a conclusion might be drawn that the WA cognitive style does feature in the attentional control function, at least for those who are at an earlier stage of language acquisition (e.g. young children and second language speakers).

In the second experiment, the task employed was essentially the same as that of the first experiment, except that only native English speakers were involved and were allowed a reasonably shorter time to perform the task (i.e. increasing the task difficulty). Different from the second language speakers, native speakers did not exhibit any difference in attentional control related performance according to their WA cognitive styles. Instead of conflicting with the conclusion of the first experiment, it was argued that such a null finding resulted from the “coverage” of the influence of language proficiency. Native adult speakers, who normally have mastered the language well, might no longer depend much on attentional control effort during their language processing. Hence, their WA cognitive style fails to show an effect on the metalinguistic performance. In addition, an issue of “attentional control skill” has been raised to explain the ‘cover-up’ effect of the finding. At the later stage of language acquisition (even probably at a proficient stage of many activities) individuals may be capable of developing the relevant skills to compensate their initial disadvantages caused by their natural cognitive styles, and consequently they attain

a similar level of performance to their peers. In this case, the WA cognitive style may be still involved in the attentional control function for native participants, but the relationship is very likely covered by the employment of the nurtured attentional control skills.

Chapter 4 focused on the question of whether the WA cognitive style is an influential factor in stereotypic representations. The stereotypic effect of memory was assumed as a consequence of accessibility to pre-existing knowledge frameworks. With presented stereotype labels (e.g. “doctor”) those stereotype related traits (e.g. “caring”, which is consistent with the knowledge framework of “doctor”) are more accessible during information organising. Hence, they are easier to remember. The WA cognitive style was found to be an influence on this process. Overall, wholist participants were dependent on the conditions according to both the presence of the stereotype labels (i.e. explicit clues referring to pre-existing stereotypic frameworks) and the congruity of the traits (i.e. related or neutral to stereotypic knowledge frameworks). In contrast, analytic participants’ performances were merely affected by the presence of the stereotype labels but not the congruity of the traits. Comparably, analytics were “material-independent” while wholists were “material-dependent” (see discussion in Subsection 7.2). The intermediate participants combined the features of holistic and analytical views, and selectively applied them to the needs of the tasks. As a result, intermediates’ performances were not affected by the presence of stereotype labels or stimuli congruity separately, but exhibited an interaction effect with outstanding memory for the stereotype consistent traits with explicitly presented stereotype labels. Moreover, results also revealed an inferior ability of wholist individuals in organising and memorising discrete information compared to analytic and intermediate individuals.

In order to test the assumption that cognitive styles may also relate to processes that are relevant to self concepts, a series of behavioural and self-report measures were



introduced in Chapter 5. In this study, both the WA and the VI cognitive styles were found to be concerned with, although in different aspects of, the self concept. Instead of the original hypothesis that the superior disembedding ability of the analytic participants might facilitate their disembodiment process (i.e. taking a mental position outside of the body), the wholists were found to have an advantage in both the embodiment (the control task) and the disembodiment tasks. Thus, the WA cognitive style was purported to affect a more fundamental process of the spatial self perception (i.e. integrate bodily information into a holistic perception) rather than the sole disembodiment process. The VI cognitive style failed to show any effect on the two tasks. Nevertheless, the levels of empathy and attachment anxiety (i.e. a scale of other-oriented social attention) were reported relevant to the VI cognitive style but not the WA cognitive style. Imagers who can represent information in a more concrete scale found it easier to understand others' mental states and consequently, gave appropriate emotional responses. Verbalisers tend to view the world in a more abstract propositional manner, and accordingly found it difficult to work out intuitively others' feelings. Moreover, female verbalisers were reported to be more anxious to their partners than female imagers (which may reflect an over-attention towards others in order to secure the proximity of the relationship). The VI cognitive style had no effect for males. Such a gender difference was attributed to the additive effect of the external focus of verbalisers and the pessimistic tendency (i.e. to perceive information as negative) for female verbalisers but not male verbalisers.

Finally, after introducing a substituting measure of the VI test of CSA with improved reliability, the validity of the VI cognitive style was re-examined in Chapter 6. The results can be categorised into two parts.

First, although the confounding effect of the unreliable measure has been eliminated, the VI cognitive style failed to show predicted relationships with other

individual difference constructs, which were proposed as sharing relevant brain mechanisms with the VI style. Secondly, three behavioural experiments (mental rotation, lexical decision, and relatedness judgement; either imagery or verbal natured) using a priming paradigm examined three hypothetical assumptions according to the current operational definition of the VI cognitive style. (More discussion about the assumptions will be presented in Subsection 7.3.) None of the experiments provided support for any of the three hypotheses. Therefore, the theoretical definition of the VI cognitive style has been critically discussed with questions about the true relationship between the two coding systems. Instead of the *one-or-the-other* relationship, an *additive* relationship between the verbal and imagery representing systems is proposed. Further, the successful applications of the VI test of CSA within education were arguably due to the pseudo VI style detecting children with a later developed verbal system. These results urge a serious re-consideration of the VI dimension of cognitive style itself.

Having outlined the findings, the following sections narrate the implication of these results from four aspects; the WA and the VI cognitive style dimension separately, the interaction between the two dimensions, and the confusable concept of style/skill.

## **7.2 Extending Understanding of the WA Cognitive Style Dimension**

With supportive evidence of its reliability and validity in the literature, the WA cognitive style dimension has been mainly investigated in this thesis in order to extend the understanding of its nature. Evidence from the research described here reflects different aspects of functions of this cognitive style dimension.

The correlation between the WA cognitive style and preference in concrete experience (i.e. CE scores) in Chapter 2 expressed an aptitude for wholists that inclines towards intuitive, receptive, and first-hand situations for learning experiences. Although



this result is not directly related to cognitive performances, it points out some features that are related to this cognitive style dimension. An individual's preferred organisation manner, either global or analytical, may lead to varied predilections for intuition, concreteness, and feeling of information input. This result might yield extensive application in not only educational, but also other fields of practice and interest. A systematic approach was also suggested to be associated with an analytic style, notwithstanding that the link might have been concealed by the impact of environmental factors (e.g. education).

The other results of Chapters 2 and Chapter 3 indicated an obvious relation between the disembedding process and the WA cognitive style. The WA style succeeded from the idea of the FDI cognitive style, which was famously characterised with disembedding ability (Witkin et al., 1971). Such a kin relationship undoubtedly features the WA dimension with the disembedding functioning as suggested by experimental findings. In Chapter 2, the WA style ratios were positively correlated with the GEFT performance, which was measured by how many disembedded figures could be outlined within a certain time limit. The more analytical an individual is, the more capable s/he is in disembedding figures from a complex background. The results of Chapter 3 were, in addition, consistent with this conclusion. Analytic individuals who are in their earlier stage of language acquisition (when some relevant skills have not yet developed) are more able to disembed selectively their attentions from context meaning and direct them to the required aspect of input information (e.g. grammar and spelling). Both results added support to the notion that the WA cognitive style plays a role in disembedding functioning.

However, the WA cognitive style dimension does not only entail the disembedding ability, which always favours analytic individuals. The influence of style should be either positive or negative depending on the task type rather than a uni-dimensional increase for all tasks (Riding, 1997). The new WA cognitive style (Riding & Cheema, 1991) was

shown to fulfil well this requirement.

Riding and Cheema (1991) emphasised the WA cognitive style dimension with two ends (i.e. wholist versus analytic) by conceptualising it as the way by which individuals tend to organise information, either globally or in parts. Thus, an individual at one end of the dimension (e.g. wholist) might find it hard to accomplish a particular task while someone at the other end of the dimension (e.g. analytic) may feel the same task is easy. More importantly, the situation can be reversed for another task. In short, individuals with different cognitive styles can be good and poor respectively at different tasks (whilst they are determined to be good or poor for all tasks according to their *ability*). It makes this style distinct from the impact of ability (Riding, 1997). Results in Chapters 4 and 5 have presented this contrast evidence for both wholist and analytic style groups.

In Chapter 5, analytic participants were originally hypothesised to exhibit faster reaction times in the perspective transformation (disembodiment) task because of their superior disembedding abilities. But it was found that wholists demonstrated better performance in both disembodiment and the embodiment (control) tasks. Despite a lack of comparison results, it was suggested that wholists do have an advantage in integrating bodily information into a holistic self perception. In this task, the advantage of global organisation of information probably overwhelmed the advantage of disembedding functioning.

Chapter 4 investigated how individuals with different WA cognitive styles would deal with information with or without accessing pre-existing knowledge frameworks. Wholist individuals were found to have a significant handicap compared to their peers in organising and perceiving irrelevant items without an organising theme. Rather, they were sensitive to implicit relations between items (i.e. their recall performance was significantly better for stereotype consistent traits than stereotype neutral traits even without an explicit



stereotype label to remind the pre-existing frameworks). Analytic individuals, in contrast, were not so sensitive to the undercover relations (i.e. their recall performance was no different for stereotype consistent and stereotype neutral traits without an explicit stereotype label) but were good at memorising discrete items. These results illustrate well the features of their favoured organisations. Wholists perceive information with an intuitive, global view with little concern about details (that are not significantly relevant to the main idea). In contrast, analytics perceive with their attention on all the details but probably at the expense of the holistic view. In addition, overall wholist individuals were found to be more “material-dependent” in that their performances were corresponding to implicit material features. Analytic individuals were relatively more “material-independent” as their performances were determined by explicit clues (e.g. presence of the stereotype labels) but not implicit ones (e.g. stereotype related or neutral traits). Intermediates, who are able to utilise freely both the holistic and analytic organisation during information process, flexibly employed either feature and ultimately, showed the best recall performance.

Results from Chapter 4 may also have practical implications. Stereotypic perceptions about others are normal phenomena in everyday life. This has been discussed in Chapter 4. However, even presenting the same information, individuals with different WA cognitive styles may achieve varied stereotypic perceptions. For example, wholist persons are more sensitive to stereotypic information, no matter whether it is explicitly clued (even if it is falsely clued) or implicitly hidden; but have poor memory of non-stereotypic information. Hence, they are inclined to hold stereotypic impressions of others. Analytic people would respond to explicitly stereotypic clues but they are not affected by implicitly stereotypic information. Intermediates are the most fastidious ones for stereotypic perceptions. Stereotypic bias only appears for them when information and the

explicit clue are matched.

On all counts, the findings profile different strands of evidence that are presented in this thesis to exhibit various facets of the nature of the WA cognitive style dimension. These can be concluded and extended as follows. Individuals who locate at the wholist end of the dimension tend to organise information in a global way and accordingly manifest an intuitive manner of perceiving information as well as sensitivity to implicit relationships hidden in materials. They are good at integrating pieces of information into a holistic concept, but impaired at perceiving/memorising discrete units and disembedding parts from a whole. Individuals who locate at the analytic end of the dimension tend to organise information in an analytical manner and do not prefer the situations where they need to “feel”. Hence they are insensitive to the “hidden” information when they perceive and rationally organise information based on explicit clues. Analytic individuals, in comparison to wholist ones, are good at perceiving/memorising discrete information and show a superior disembedding ability.

### **7.3 The VI Cognitive Style Dimension: A valid cognitive style dimension?**

The original concept of the VI cognitive style dimension can be analogised as two windows. One “window” is the verbal coding system while the other “window” is the non-verbal (imagery) coding system. The verbal “window” contains logogens (verbal representations) that describe information with abstract, propositional, and referentially arbitrary features. The imagery “window” comprises imagens (imagery representations) with analogue, iconic, and referentially isomorphic information. To change a representation mode, one needs to switch from one window to the other. In this case, the VI cognitive style reflects which “window” is the primary one that the person uses most frequently and efficiently.



The findings in Chapter 2 provided some support to this style dimension. In line with the prediction, individuals who are more engaged with the verbal “window” during information processing tend to learn by conceptualising knowledge into theories. Individuals who are habitual to use the imagery “window” prefer to learn by feeling the concrete experiences. Either preference is congruent with the features of each “window”, respectively.

Otherwise, Chapter 5 discussed the impact of the VI cognitive style on social perceptions. There was an imager superiority reported for empathy. It is explained in that the imagery “window” can enhance the empathic process because of its richness of concrete details of information. In addition, the VI style interacted with gender to influence individuals’ attachment anxiety, which may manipulate people’s other-oriented social behaviours. This might be attributed to the external-internal focus caused by the VI cognitive style and its interaction with gender on pessimistic perceptions.

However, it needs to be remembered that all the preceding findings were gained by the VI test of the CSA with a questionable reliability. And the results of Chapter 6 (after substitution of the measure with a more reliable one) further reduced credit for those conclusions of the VI cognitive style. The present definition of the VI cognitive style is based on a *one-or-the-other* presumption of the two “windows”. That is, when performing a task, only one “window” is always being used. If this is true, three assumptions of each priming experiment can be made: 1) an individual’s performance on a specific task should be influenced by his/her VI cognitive style as the primary “window” should be more efficient in performing congruent tasks; 2) congruent primes should facilitate the following target task and *vice versa*, because the user does not need to switch between the two “windows”, which saves time; 3) switch from the primary “window” to the secondary one should cost more effort than the opposite process. However, the three priming experiments

supported none of these assumptions. Moreover, the null finding of an investigation of the relationship between the VI style and other related brain-based constructs further discredited its validity. Both sets of findings could be said to challenge the current theoretical basis of the VI cognitive style dimension.

The selective interference effect (see Chapter 1) which demonstrates that performance on a cognitive task can be selectively impaired by another competing cognitive process using the same “window” (i.e. either verbal or imagery coding system) establishes two distinct verbal and imagery representing systems. However, it is not enough to establish a simple *one-or-the-other* relation between the two systems as Riding and Cheema (1991) assumed. Rather, there is evidence (e.g. Begg, 1972; Paivio, 1967; 1975; Paivio & Csapo, 1973) to suggest that the two “windows” are able to work simultaneously and add their effects together (i.e. the concreteness advantage of memory).

In this manner, the relation between the two “windows” can be inferred to be analogous with the relation between the functions of the two brain hemispheres (although Paivio did not explicitly express this). Cognitive processes probably depend on conjoint functioning of both representing systems, but each coding system can be dominant in particular tasks. For example, the verbal system is essential for language and imagery system is indispensable in spatial tasks. For most tasks, both systems are making their contributions, as has been claimed by Paivio (2007). When performing two tasks at the same time, if both tasks depend heavily on one “window” (e.g. the verbal system) the capacity of the “window” might limit the performance of both tasks (i.e. a ceiling effect) and result in the selective interference effect. If the two tasks mainly depend on either “window” respectively, no ceiling effect happens and consequently no interference is found on performance. The concreteness advantage of memory is also a result of the dual coding (an additive effect) from the collaboration of two “windows”.



Therefore, the present operational definition (e.g. CSA/VICS) of the VI cognitive style is argued to be inappropriate. Because both representing systems are involved in every task question (no matter whether verbal or imagery), the reaction times are no longer proper indexes of the efficiency of each system. Consequently the reaction time ratio has very limited meaning for the VI cognitive style. This is possibly responsible for the non-significant results in Chapter 6 and the reason for a narrow distribution of the VI style ratios in normal population. So it is suggested that a new measure of VI cognitive style (with a new method) is necessary. And a definition needs to be critically discussed and decided. Further studies are urgently required.

Finally, in order to dispel the possible confusion caused by those successful applications of the VI cognitive style in classrooms, a pseudo VI style effect is purported to be observed in children. Paivio (2007) proposed that the verbal system is a later developed product than the non-verbal system. The “imagery” children detected by CSA might have been falsely categorised from those who have not yet fully developed their verbal system. Hereby, their disadvantage during education (i.e. they do not suit teaching which involves a majority of verbal materials) was significantly helped by complementary pictorial or multi-media presentation of teaching.

To sum up, the current operational definition of the VI cognitive style has been critically evaluated in this thesis. Unsupportive evidence has been presented to its validity and theoretical basis. Thus, the measures of the VI style that are based on *one-or-the-other* assumption between the two representing systems are suggested to be inappropriate, which might have caused confusion in the area of research. More research is required to examine current findings. If they are confirmed to be true, exploratory reviews are needed to re-establish a new acceptable definition of the VI cognitive style.

As well as covering each cognitive style dimension separately, the next section will

discuss a possible interaction between the two style dimensions; the “adaptation”, which has been mentioned in Chapter 1.

#### **7.4 “Adaptation” between the WA and the VI Cognitive Style Dimensions**

Chapter 1 discussed the “adaptation” between the WA and the VI cognitive style dimensions and showed that the verbal representation may complement the analytic feature of organisation while the imagery representation is able to provide a holistic view. In this way, the VI style dimension can assist to substitute (more or less) the WA style dimension when the latter feature is not available. Meanwhile, Riding and Rayner (1998) explicitly claimed the independence between the two style dimensions. Is there any conflict between the two statements? If not, what is the relation between them? Some of the results in Chapter 2 may have given hints for this question.

In Chapter 2, both the WA and the VI cognitive style dimensions were found to be correlated with the concrete-abstract learning style dimension whereas the two cognitive style dimensions were independent from one another. This indicates that the WA and VI style separately and independently account for part of the variance of the concrete-abstract dimension. As this learning style dimension was suggested to locate at an outer layer of the onion model (Curry, 1983) the concrete-abstract dimension can be regarded as a co-operating product of the two distinct underlying cognitive style dimensions. That is, the WA and the VI style are independent from each other at the cognitive style level but are able to interact to form new modifiable characteristics (e.g. learning style) in a more activity-centred level to adapt specific learning demands. This might inspire us to clarify the adaptation between the two cognitive style dimensions. The adaptation is not necessary to contradict the independence between the WA and the VI style dimensions since they may happen at different levels of an individual’s characteristics. The results of Chapter 2



are, at least, consistent with this postulation.

In addition, Riding and Rayner (1998) briefly described the adaptation between the two style dimensions as a strategy resulting from utilising an awareness of style in order to enhance learning. Hence, they implied that the adaptation is the product of a conscious activity based on the understanding of one's own styles. However, the finding of Chapter 2 may partially disagree with this assertion. Participants were not informed of their cognitive styles when they were reporting their learning preferences in Chapter 2. Thus, their adaptation process could only reflect the learning style dimension rather than being a conscious choice based on knowledge. It is suggested that the two underlying distinct cognitive styles (WA and VI) can be spontaneously utilised to work interactively in order to adapt to the environmental requirements. Hence, the adaptation process between the WA and the VI cognitive styles may be employed not only intentionally when individuals are aware of their styles, but also automatically.

In summary, findings in Chapter 2 have been discussed to support and extend, although indirectly, the understanding of the "adaptation" process between the WA and the VI cognitive style. A future behavioural study, which examines individuals' holistic/analytic views according to their cognitive style groups, may add more direct evidence to the postulation. Wholist-verbalisers are proposed to exhibit better analytical organisation of information than wholist-imagers whereas both of them gain only the holistic feature from the WA style dimension; the verbal representation would adapt to compensate the disadvantage of the lack of an analytical view. Likewise, analytic-imagers would show better holistic organisation than analytic-verbalisers since the imagery representation may import the global view of information. If the predicted results are found with participants, with or without the knowledge of their own cognitive styles, the adaptation process would be fully established to be an existing and automatic process.

## **7.5 Variability or Invariability of Cognitive Styles: A possible confusion between style and skill**

Chapter 1 also reported that confusion exists in previous studies about the variability/invariability of cognitive styles. Most researchers agree that cognitive styles should at least be “partially fixed and relatively stable” (e.g. E. Peterson, S. Rayner, & S. Armstrong, personal communication, May 21, 2008). However, contrasting evidence shows that in some cases individuals’ cognitive styles do appear malleable (see Chapter 1). Are these conflicting findings merely due to sampling or do they reflect other variables?

Results in Chapter 3 have provided another possible explanation for the unstable findings of styles: namely, the development of corresponding skills which may substitute the functions of styles. The first experiment in Chapter 3 has established that at the earlier stage of language acquisition (e.g. young children and second language speakers) the WA cognitive style may entail the attentional control functioning during metalinguistic processes, and resultingly affect relevant performances. However, such a cognitive style effect is eliminated at a latter stage of language acquisition (e.g. adult native speakers). One explanation of this is that the effect of the natural cognitive style (WA) is “overwritten” by the influence of a similar functioning skill to compensate the disadvantage of situations to which the cognitive style is not ideally suited (see discussion in Chapter 3). Those skills were developed with years of practice. In other words, nurtured skills that are functionally analogous to the cognitive styles can be developed (probably within a particular activity) and finally, will interfere with the impact of an individual’s original cognitive style on behaviour (which very likely will lead to an improvement in performance).

Taking this one step further, the conflicting evidence about the stability of cognitive styles might result from the same reason. That is, the lack of distinction between style and



skill in much research. Style is probably fairly fixed for individuals. However, corresponding skills are malleable and vary according to situation demands. The latter, if it mutually exists with style, might lead to confusing results about the invariability of cognitive styles. Chapter 3 has pointed out that caution should be applied in the superposition between style and skill. It could not only muddle our understanding of the variability of styles, but also other important aspects of styles (e.g. applications in teaching, etc.).

In addition, the development of style-compensated skills on human activities also implies a profound optimistic perspective in style research. Cognitive styles are regarded as relatively fixed, invariable individual characteristics with both advantages and disadvantages during learning activities. Hence, most researchers have focused on how to proffer supportive environments for individuals so that they can perceive and process information in their preferred ways, and consequently enhance their learning performance. Here individuals are (implicitly) viewed as passive recipients. However, the spontaneous utilisation of substituted skills to compensate the disadvantage of original styles, and the adaptation between the two cognitive style dimensions, have disclosed another aspect of the understanding of styles: namely, human ability to adapt to the environments. Our cognitive styles may be unable to change or be modified, but humans are positive and active to adapt to the world. Accordingly, we generate different skills/strategies in diverse situations to compensate for our innate disadvantages during activities. This was an example demonstrated in Chapter 3. Despite natural disadvantages, wholist individuals can achieve equivalent performance on attentional control tasks to analytic peers with the help of self-developed skills. Humans always tend to, and probably are able to, make the best of situations even if the environments are not supportive (i.e. the environment does not suit their styles). Thus, the capability of the human should not be underestimated. Future

research should emphasise how to inspire individuals, especially children, to devise useful skills to adapt themselves to diverse situations rather than simply put them into fully supportive environments.

## **7.6 Conclusions**

Overall, the findings presented in this thesis provide further experimental evidence in inspecting the WA and the VI cognitive style dimensions. The WA cognitive style has been established to be a valid and reliable construct and to have impact on various cognitive processes, such as disembedding function in figures and metalinguistic tasks, stereotypic perceptions, and integrated bodily perception of self. All these observed relationships were discussed to be consistent with the view of an organisation aptitude of the WA cognitive style. In contrast, the VI style dimension, which is assumed to be concerned with information representation, failed to gain support for its validity after controlling for reliability. The current operational definition of the VI style has been critically evaluated and it is suggested that a re-consideration of the theoretical basis of the style is needed before the practical success of its application can be claimed. In addition, the adaptation between the two independent style dimensions has been discussed. A distinction between style and skill needs to be made in future research.

## **7.7 Future Research**

While the new laboratory evidence reviewed in this body of work advances (more or less) the understanding of the nature of the two cognitive style dimensions (WA and VI), a number of new questions appear and further research is need to clarify these. They are summarised as follows.

- 1) *The VI Cognitive Style*. Clarification of the concept of the VI cognitive style



is needed. Can the conclusion of Chapter 6 be confirmed by a more extensive range of evidence? If so, the measure of the VI style must change. In other words, the operational definition of the VI style needs to move to a valid one. What will it be? And after modifying the definition, can it still fulfil the criteria of a “cognitive style”? All these questions imply much work is required. And until this happens, caution is needed when applying the style into practice.

2) *Style and Skill*. The possible interaction between styles and skills has been discussed. In order to avoid confusion in future style research, distinguishing skills from styles is important. This might clarify some of the mixed evidence relating to styles, such as invariability, relationship with other constructs, etc. Besides that, how can a relevant skill be fostered on the basis of a particular style in a particular situation? For example, individuals with certain cognitive styles may find it difficult to accomplish a specific task. How would they develop an effective skill to compensate for this natural disadvantage? And what is the role that previous experiences play during this process? All these questions are of interest and need to be investigated with both theoretical and applied approaches.

3) *Other Style Dimensions*. Although Riding and Cheema (1991) reviewed over 30 cognitive style descriptors to categorise the WA and VI dimension, there may still be ones omitted. Chapter 2 has proposed that the reflective-active dimension (AERO; Kolb & Kolb, 2005) was independent from either the WA or the VI cognitive style dimension. The reflective-active dimension has been identified as a learning style, but there is the possibility that more cognitive style dimensions other than WA and VI may exist. Their exploration in future work will be of great value in helping our understanding of this field of research.

The work that comprised this thesis has also been published in the following peer reviewed journals and conferences:

#### Journal Papers

Zhang, M., & Noyes, J. M. (2007). Individual differences and academic performances of British and Chinese university students. *The Psychology of Education Review*, 31(1), 17-26.

Zhang, M., & Noyes, J. M. (2008a). Wholist-Analytic style and context as variables in metalinguistic performance: An investigation of second language speakers. *The Psychology of Education Review*, 32(1), 45-54.

Zhang, M., & Noyes, J. M. (2008b). Wholist-Analytic style and context as variables in metalinguistic performance: A follow-up study of adult native speakers. *The Psychology of Education Review*, 32(1), 55-61.

#### Conference Papers<sup>§</sup>

Zhang, M., & Noyes, J. M. (2006, June 12-14th). *Riding's cognitive style model: A stable construct?* Paper presented at the 11th Annual Conference of the European Learning Styles Information Network (ELSIN), University of Oslo, Oslo, Norway.

Zhang, M., & Noyes, J. M. (2007a, July 9-10th). *Wholist-analytic style and context as variables in metalinguistic performance: An investigation on second language speakers.* Paper presented at the International Conference on Psychology, Athens, Greece.

Zhang, M., & Noyes, J. M. (2007b, June 12-14th). *Wholist-analytic style and context as variables in metalinguistic performance: What does it imply for language*

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<sup>§</sup> Note. The last two conference papers were later revised to the journal papers Zhang and Noyes (2008a; 2008b).



*processing?* Paper presented at the 12th Annual Conference of the European Learning Styles Information Network (ELSIN), Trinity College, Dublin, Ireland.

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## Appendix A. Learning Style Inventory (LSI) Version 3.1 (Kolb & Kolb, 2005)

### LEARNING-STYLE INVENTORY

The Learning-Style Inventory describes the way you learn and how you deal with ideas and day-to-day situations in your life. Below are 12 sentences with a choice of endings. Rank the endings for each sentence according to how well you think each one fits with how you would go about learning something. Try to recall some recent situations where you had to learn something new, perhaps in your job or at school. Then, using the spaces provided, rank a "4" for the sentence ending that describes how you learn *best*, down to a "1" for the sentence ending that seems least like the way you learn. Be sure to rank all the endings for each sentence unit. Please do not make ties.

Example of completed sentence set:

1. When I learn: 2 I am happy. 1 I am fast. 3 I am logical. 4 I am careful.

Remember: 4 = *most* like you 3 = *second most* like you 2 = *third most* like you 1 = *least* like you

|                         | A  | B  | C  | D  |
|-------------------------|--|--|--|--|
| 1. When I learn:        | <input type="checkbox"/> I like to deal with my feelings.    | <input type="checkbox"/> I like to think about ideas.    | <input type="checkbox"/> I like to be doing things.                                  | <input type="checkbox"/> I like to watch and listen.           |
| 2. I learn best when:   | <input type="checkbox"/> I listen and watch carefully.       | <input type="checkbox"/> I rely on logical thinking.     | <input type="checkbox"/> I trust my hunches and feelings.                            | <input type="checkbox"/> I work hard to get things done.       |
| 3. When I am learning:  | <input type="checkbox"/> I tend to reason things out.        | <input type="checkbox"/> I am responsible about things.  | <input type="checkbox"/> I am quiet and reserved.                                    | <input type="checkbox"/> I have strong feelings and reactions. |
| 4. I learn by:          | <input type="checkbox"/> feeling.                            | <input type="checkbox"/> doing.                          | <input type="checkbox"/> watching.   | <input type="checkbox"/> thinking.                             |
| 5. When I learn:        | <input type="checkbox"/> I am open to new experiences.       | <input type="checkbox"/> I look at all sides of issues.  | <input type="checkbox"/> I like to analyze things, break them down into their parts. | <input type="checkbox"/> I like to try things out.             |
| 6. When I am learning:  | <input type="checkbox"/> I am an observing person.           | <input type="checkbox"/> I am an active person.          | <input type="checkbox"/> I am an intuitive person.                                   | <input type="checkbox"/> I am a logical person.                |
| 7. I learn best from:   | <input type="checkbox"/> observation.                        | <input type="checkbox"/> personal relationships.         | <input type="checkbox"/> rational theories.  | <input type="checkbox"/> a chance to try out and practice.     |
| 8. When I learn:        | <input type="checkbox"/> I like to see results from my work. | <input type="checkbox"/> I like ideas and theories.      | <input type="checkbox"/> I take my time before acting.                               | <input type="checkbox"/> I feel personally involved in things. |
| 9. I learn best when:   | <input type="checkbox"/> I rely on my observations.          | <input type="checkbox"/> I rely on my feelings.          | <input type="checkbox"/> I can try things out for myself.                            | <input type="checkbox"/> I rely on my ideas.                   |
| 10. When I am learning: | <input type="checkbox"/> I am a reserved person.             | <input type="checkbox"/> I am an accepting person.       | <input type="checkbox"/> I am a responsible person.                                  | <input type="checkbox"/> I am a rational person.               |
| 11. When I learn:       | <input type="checkbox"/> I get involved.                     | <input type="checkbox"/> I like to observe.              | <input type="checkbox"/> I evaluate things.  | <input type="checkbox"/> I like to be active.                  |
| 12. I learn best when:  | <input type="checkbox"/> I analyze ideas.                    | <input type="checkbox"/> I am receptive and open-minded. | <input type="checkbox"/> I am careful.   | <input type="checkbox"/> I am practical.                       |

MCB200C

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## **Appendix B. Two example texts used in the metalinguistic task**

### **1) The text in the meaningful context:**

“Cannes Film Festival, the most prestigious motion picture festival in the world held each May in resort city of Cannes, in southeast France. The Cannes Film Festival was conceived at the end to 1938 as a reaction of a reports that the Venice Film Festival became a platform for fascist propaganda. Due to World War II (1939 – 1945), however, the first Cannes Film Festival was not held until 1946. Internationalism and post-war optimism characterize the first festival, as organizers placed less emphasis on competition than on mutual creative stimulation between national productions. In later years the selection, by juries, of entries for prizes reflects more commercial interests and the festival soon acquired its current reputation as fashionable professional events, more concerned with advancing the film industry than the art of film. French director Francois Truffaut addressed these issues in 1956 when he exposed festival’s political intrigues and promotional deals, and predicts its commercial demise. The festival survives, however and in 1959, Truffaut himself was awarded the prize for best screenplay for *Les quatre cents coups* (The Four Hundred Blows, 1959).

In spite of its ever present financial interests and political overtones, the Cannes Film Festival remains an essential showcase for international cinema.”



2) The text in the meaningless context:

“Cannes Film Festival, the most logical motion picture festival in the world held each May in resort city of Cannes, in southeast France. The Cannes Film Festival was laughed at the end to 1938 as an introduction of a reports that the New York Film Festival became a classroom for poverty propaganda. Due to World War II (1939 – 1945), however, the first Cannes Film Festival was not handed until 1946. Beauty and loneliness optimism characterize the first festival, as organizers placed more emphasis on competition than on mutual productive stimulation between national schools. In later years the selection, by juries, of students for prizes reflects more fairy interests and the festival soon acquired its current reputation as huffy violent events, more concerned with advancing the plastic industry than the art of music. French director Francois Truffaut addressed these issues in 1956 when he exposed festival’s stupid intrigues and promotional deals, and predicts its commercial demise. The festival survives, however and in 1959, Truffaut himself was awarded the notebook for best picture for *Les quatre cents coups* (The Four Hundred Blows, 1959).

In spite of its ever present industrial interests and artistic overtones, the Cannes Film Festival remains an essential hotel for international cinema.”

### Appendix C. The recall sheet used in the stereotype study

## Recall Sheet

Now is the final part of the experiment -recall. There are the four persons' names listed in the table below. You are required to write down under each name as many of the traits that were originally paired with each individual as possible. You will have 10 minutes for the recall.

[illegible]



## Appendix D. The Empathy Quotient (EQ)

Please indicate the correct answer (EQ scale)

|  | Definitely agree | Slightly agree | Slightly disagree | Definitely disagree |
|--|------------------|----------------|-------------------|---------------------|
| 1. I can easily tell if someone else wants to enter a conversation.  |                  |                |                   |                     |
| 2. I prefer animals to humans.   |                  |                |                   |                     |
| 3. I try to keep up with the current trends and fashions.  |                  |                |                   |                     |
| 4. I find it difficult to explain to others things that I understand easily, when they don't understand it first time. |                  |                |                   |                     |
| 5. I dream most nights.  |                  |                |                   |                     |
| 6. I really enjoy caring for other people.   |                  |                |                   |                     |
| 7. I try to solve my own problems rather than discussing them with others.   |                  |                |                   |                     |
| 8. I find it hard to know what to do in a social situation.  |                  |                |                   |                     |
| 9. I am at my best first thing in the morning.   |                  |                |                   |                     |
| 10. People often tell me that I went too far in driving my point home in a discussion.                                 |                  |                |                   |                     |
| 11. It doesn't bother me too much if I am late meeting a friend.   |                  |                |                   |                     |
| 12. Friendships and relationships are just too difficult, so I tend not to bother with them.                           |                  |                |                   |                     |
| 13. I would never break a law, no matter how minor.  |                  |                |                   |                     |
| 14. I often find it difficult to judge if something is rude or polite.   |                  |                |                   |                     |
| 15. In a conversation, I tend to focus on my own thoughts rather than on what my listener might be thinking.           |                  |                |                   |                     |
| 16. I prefer practical jokes to verbal humour.   |                  |                |                   |                     |
| 17. I live life for today rather than the future.  |                  |                |                   |                     |
| 18. When I was a child, I enjoyed cutting up worms to see what would happen.   |                  |                |                   |                     |
| 19. I can pick up quickly if someone says one thing but means another.   |                  |                |                   |                     |
| 20. I tend to have very strong opinions about morality.  |                  |                |                   |                     |
| 21. It is hard for me to see why some things upset people so much.   |                  |                |                   |                     |
| 22. I find it easy to put myself in somebody else's shoes.   |                  |                |                   |                     |
| 23. I think that good manners are the most important thing a parent can teach their child.                             |                  |                |                   |                     |
| 24. I like to do things on the spur of the moment.   |                  |                |                   |                     |
| 25. I am good at predicting how someone will feel.   |                  |                |                   |                     |
| 26. I am quick to spot when someone in a group is feeling awkward or uncomfortable.                                    |                  |                |                   |                     |
| 27. If I say something that someone else is offended by, I think that that's their problem, not mine.                  |                  |                |                   |                     |
| 28. If anyone asked me if I liked their haircut, I would reply truthfully, even if I didn't like it.                   |                  |                |                   |                     |
| 29. I can't always see why someone should have felt offended by a remark.  |                  |                |                   |                     |
| 30. People often tell me that I am very unpredictable.   |                  |                |                   |                     |
| 31. I enjoy being the centre of attention at any social  |                  |                |                   |                     |

TBC

|  |  |  |  |  |
|--|--|--|--|--|
| gathering.   |  |  |  |  |
| 32. Seeing people cry doesn't really upset me.   |  |  |  |  |
| 33. I enjoy having discussions about politics.   |  |  |  |  |
| 34. I am very blunt, which some people take to be rudeness, even though this is unintentional.       |  |  |  |  |
| 35. I don't tend to find social situations confusing.  |  |  |  |  |
| 36. Other people tell me I am good at understanding how they are feeling and what they are thinking. |  |  |  |  |
| 37. When I talk to people, I tend to talk about their experiences rather than my own.                |  |  |  |  |
| 38. It upsets me to see an animal in pain.   |  |  |  |  |
| 39. I am able to make decisions without being influenced by people's feelings.                       |  |  |  |  |
| 40. I can't relax until I have done everything I had planned to do that day.                         |  |  |  |  |
| 41. I can easily tell if someone else is interested or bored with what I am saying.                  |  |  |  |  |
| 42. I get upset if I see people suffering on news programmes.  |  |  |  |  |
| 43. Friends usually talk to me about their problems as they say that I am very understanding.        |  |  |  |  |
| 44. I can sense if I am intruding, even if the other person doesn't tell me.                         |  |  |  |  |
| 45. I often start new hobbies but quickly become bored with them and move on to something else.      |  |  |  |  |
| 46. People sometimes tell me that I have gone too far with teasing.                                  |  |  |  |  |
| 47. I would be too nervous to go on a big roller coaster.  |  |  |  |  |
| 48. Other people often say that I am insensitive, though I don't always see why.                     |  |  |  |  |
| 49. If I see a stranger in a group, I think that it is up to them to make an effort to join in.      |  |  |  |  |
| 50. I usually stay emotionally detached when watching a film.  |  |  |  |  |
| 51. I like to be very organized in day-to-day life and often make lists of the chores I have to do.  |  |  |  |  |
| 52. I can tune in to how someone else feels rapidly and intuitively.                                 |  |  |  |  |
| 53. I don't like to take risks.  |  |  |  |  |
| 54. I can easily work out what another person might want to talk about.                              |  |  |  |  |
| 55. I can tell if someone is masking their true emotion.   |  |  |  |  |
| 56. Before making a decision I always weigh up the pros and cons.                                    |  |  |  |  |
| 57. I don't consciously work out the rules of social situations.                                     |  |  |  |  |
| 58. I am good at predicting what someone will do.  |  |  |  |  |
| 59. I tend to get emotionally involved with a friend's problems.                                     |  |  |  |  |
| 60. I can usually appreciate the other person's viewpoint, even if I don't agree with it.            |  |  |  |  |



## **Appendix E. Categorisation of the items of EQ into three subscales: “cognitive empathy”, “affective empathy”, and “social skills”**

Lawrence et al. (2004) applied a principal component analysis on the initial EQ questionnaire and concluded three factors remaining in the questionnaire: “cognitive empathy”, “affective empathy”, and “social skills”. The categorisation in the present study was based on their work.

Twelve of forty target questions were removed from further analysis because of the low correlations with the overall model and other items. Twenty-eight questions remained. The ‘cognitive empathy’ subscale was with question 1, 19, 22, 25, 26, 36, 41, 44, 52, 54, 55, 58; ‘affective empathy’ subscale was with question 6, 21, 27, 29, 32, 42, 43, 48, 50, 59; and ‘social skills’ subscale was with question 4, 8, 12, 14, 35, 57. Question 1, 22, 36, and 43 had double loadings in two factors. Among them, question 1 and 36 were allocated according to their biggest loading (‘cognitive empathy’, load 0.50 compared to 0.30 in the other factor). Question 22 and 43 had a similar loading in both ‘cognitive empathy’ and ‘affective empathy’. They were allocated to either factor on the basis of content.

## Appendix F. The revised version of the Experiences in Close Relationships

### Questionnaire (ECR)

Please indicate the extent to which you agree with the following statements. Do this by placing a number from the scale below (1 – 7) in front of each state

| Strongly<br>disagree |        |        | Neutral |        |        |        |  | Strongly<br>agree |
|----------------------|--------|--------|---------|--------|--------|--------|--|-------------------|
| 1.....               | 2..... | 3..... | 4.....  | 5..... | 6..... | 7..... |  |                   |

- \_\_\_ 1. I prefer not to show people close to me how I feel deep down.
- \_\_\_ 2. I worry about being abandoned.
- \_\_\_ 3. I am very comfortable being close to others.
- \_\_\_ 4. I worry a lot about my relationships.
- \_\_\_ 5. Just when people start to get close to me I feel myself pulling away.
- \_\_\_ 6. I worry that people won't care about me as much as I care about them.
- \_\_\_ 7. I get uncomfortable when people want to be very close.
- \_\_\_ 8. I worry a fair amount about losing my relationships.
- \_\_\_ 9. I don't feel comfortable opening up to others.
- \_\_\_ 10. I often wish that my loved ones' feelings for me were as strong as my feelings for them.
- \_\_\_ 11. I want to get close to others but they keep pulling away.
- \_\_\_ 12. I often want to merge completely with others, and this sometimes scares them away.
- \_\_\_ 13. I am nervous when others get too close to me.
- \_\_\_ 14. I worry about being alone.
- \_\_\_ 15. I feel comfortable sharing my thoughts and feelings with those I am close to.
- \_\_\_ 16. My desire to be close sometimes scares others away.
- \_\_\_ 17. I try to avoid getting too close to others.
- \_\_\_ 18. I need a lot of reassurance that I am loved by those close to me.
- \_\_\_ 19. I find it relatively easy to get close to others.
- \_\_\_ 20. Sometimes I feel that I force others to show more feeling, more commitment.
- \_\_\_ 21. I find it difficult to allow myself to depend on others.
- \_\_\_ 22. I do not often worry about being abandoned.
- \_\_\_ 23. I prefer not to be close to others.
- \_\_\_ 24. If I can't get those close to me to show interest in me, I get upset or angry.
- \_\_\_ 25. I tell those close to me just about everything.
- \_\_\_ 26. I find that others don't want to get as close as I would like.
- \_\_\_ 27. I usually discuss my problems and concerns with those close to me.
- \_\_\_ 28. When I'm involved in a relationship, I feel somewhat anxious and insecure.
- \_\_\_ 29. I feel comfortable depending on others.
- \_\_\_ 30. I get frustrated when those I am close to aren't around me as much as I would like.
- \_\_\_ 31. I don't mind asking others for comfort, advice, or help.
- \_\_\_ 32. I get frustrated when those close to me are not available when I need them.
- \_\_\_ 33. It helps to turn to others in times of need.
- \_\_\_ 34. When those close to me disapprove of me, I feel really bad about myself.
- \_\_\_ 35. I turn to others for many things, including comfort and reassurance.
- \_\_\_ 36. I resent it when those I am close to spend time away from me.



## Appendix G. The Barsch Learning Style Inventory (adapted from Barsch, 1991)

### Barsch learning Style inventory

Please check the appropriate line after each statement.

|     |   | Often | Sometimes | Seldom |
|-----|---|-------|-----------|--------|
| 1.  | Can remember more about a subject through listening than reading.                                 |       |           |        |
| 2.  | Follow written directions better than oral directions.  |       |           |        |
| 3.  | Like to write things down or take notes for a visual review.                                      |       |           |        |
| 4.  | Bear down extremely hard with a pen or pencil when writing.                                       |       |           |        |
| 5.  | Require explanations of diagrams, graphs or visual directions.                                    |       |           |        |
| 6.  | Enjoy working with tools.   |       |           |        |
| 7.  | Are skillful with and enjoy developing and making graphs and charts.                              |       |           |        |
| 8.  | Can tell if sounds match when presented with pairs of sounds.                                     |       |           |        |
| 9.  | Remember best by writing things down several times.   |       |           |        |
| 10. | Can understand and follow directions on maps.   |       |           |        |
| 11. | Do better at academic subjects by listening to lectures and tapes.                                |       |           |        |
| 12. | Play with coins or keys in pocket.  |       |           |        |
| 13. | Learn to spell better by repeating the letters out loud than by writing the word on paper.        |       |           |        |
| 14. | Can better understand a news article by reading about it in the paper than by listening to radio. |       |           |        |
| 15. | Chew gum, smoke or snack during studies.  |       |           |        |
| 16. | Feel the best way to remember is to picture it in your head.                                      |       |           |        |
| 17. | Learning spelling by "finger spelling" the words.   |       |           |        |
| 18. | Would rather listen to a good lecture or speech than read about the same material in a book.      |       |           |        |
| 19. | Are good at solving and working on jigsaw puzzles and mazes.                                      |       |           |        |
| 20. | Grip objects in hands during learning period.   |       |           |        |
| 21. | Prefer listening to the news on the radio rather than reading about it in a newspaper.            |       |           |        |
| 22. | Obtain information on an interesting subject by reading relevant materials.                       |       |           |        |
| 23. | Feel very comfortable touching others, hugging, handshaking, etc.                                 |       |           |        |
| 24. | Follow oral directions better than written ones.  |       |           |        |

# BARSCH LEARNING STYLE INVENTORY SCORING PROCEDURES AND EXPLANATIONS

## SCORING PROCEDURES

OFTEN = 5 POINTS  
= 1 POINT

SOMETIMES = 3 POINTS

SELDOM

Place the point value on the line next to its corresponding item number. Next and the points to obtain the preference scores under each heading.

| Visual |       | Auditory |       | Tactual |       |
|--------|-------|----------|-------|---------|-------|
| No.    | pts   | No.      | pts   | No.     | pts   |
| 2      | _____ | 1        | _____ | 4       | _____ |
| 3      | _____ | 5        | _____ | 6       | _____ |
| 7      | _____ | 8        | _____ | 9       | _____ |
| 10     | _____ | 11       | _____ | 12      | _____ |
| 14     | _____ | 13       | _____ | 15      | _____ |
| 16     | _____ | 18       | _____ | 17      | _____ |
| 20     | _____ | 21       | _____ | 19      | _____ |
| 22     | _____ | 24       | _____ | 23      | _____ |
| _____  |       | _____    |       | _____   |       |
| VPS    |       | APS      |       | TPS     |       |

VPS = Visual Preferences Score  
APS = Auditory Preferences Score  
TPS = Tactual Preferences Score

If you are a VISUAL LEARNER, that is, you have a high visual score, then by all means be sure you see all study materials. Use charts, maps, filmstrips, notes and flashcards. Practice visualizing or picturing spelling words, for example, in your head. Write out everything for frequent and quick visual review. It is obvious you learn best when you SEE things... make it a point to see things.

If you are an AUDITORY LEARNER, that is, have auditory score, then be sure to use tapes. Sit in the front of the lecture hall or classroom where you can hear best and can review them frequently. Tape your class or lecture notes. After you read something, summarize it on tape or out loud. Verbally review spelling words, lectures or test material with a friend.

If you are a TACTUAL LEARNER, that is, have a high tactile score, trace words, for example, as you are saying them. Facts that must be learned should be written several times. Keep a supply of scratch paper just for that purpose. Taking and keeping lecture notes will be very important.

As a result of this learning inventory what do you think you can do to strengthen your learning? Give yourself some examples.



## Appendix H. Brain Dominance Inventory

### BRAIN DOMINANCE INVENTORY

Participant NO. \_\_\_\_\_

Date \_\_\_\_\_

This inventory will help determine if you are primarily a left-brain or right-brain learner, or if you are bi-lateral (using both about equally).

**Directions:** Answer the questions carefully, checking the answer that is correct for you. Select the one that most closely represents your attitude or behaviour. When you have finished, refer to the scoring instructions.

1. I prefer the kind of classes
  - ☐ a. where I listen to an authority.
  - ☐ b. in which I move around and do things.
  - ☐ c. where I listen and also do things.
2. Concerning hunches:
  - ☐ a. I would rather not rely on them to help me make important decisions.
  - ☐ b. I frequently have strong ones and follow them.
  - ☐ c. I occasionally have strong hunches but usually I do not place much faith in them or consciously follow them.
3. I usually have a place for things, a way of doing things, and an ability to organize information and materials.
  - ☐ a. Yes.
  - ☐ b. No.
  - ☐ c. In some areas of my life, but not in others.
4. When I want to remember directions, a name, or a news item, I usually:
  - ☐ a. write notes.
  - ☐ b. visualize the information.
  - ☐ c. associate it with previous information in several different ways.
5. In notetaking, I print:
  - ☐ a. never.
  - ☐ b. frequently.
  - ☐ c. sometimes.
6. I prefer the kind of classes:
  - ☐ a. where there is one assignment at a time, and I can complete it before beginning the next
  - ☐ b. one.
  - ☐ c. where I work on many things at once.

I like both kinds about equally.
7. When remembering things or thinking about things, I do so best with:
  - ☐ a. words.
  - ☐ b. pictures and images.
  - ☐ c. both equally well.
8. In reviewing instructions, I prefer:
  - ☐ a. to be told how to do something.
  - ☐ b. to be shown how.
  - ☐ c. no real preference for demonstration over oral instruction.
9. I prefer:
  - ☐ a. dogs.
  - ☐ b. cats.

- ☐ c. no preference for dogs over cats or vice versa.
10. I am:
- ☐ a. almost never absentminded.  
☐ b. frequently absentminded.  
☐ c. occasionally absentminded.
11. Do you instinctively feel an issue is right or correct, or do you decide on the basis of information?
- ☐ a. decide on the basis of information.  
☐ b. instinctively feel it is right or correct.  
☐ c. I tend to use a combination of both.
12. I have
- ☐ a. no or almost no mood changes.  
☐ b. frequent mood changes.  
☐ c. occasional mood changes.
13. I am:
- ☐ a. easily lost in finding directions, especially if I have never been to that place before.  
☐ b. good at finding my way, even when I have never been in that area.  
☐ c. not bad in finding directions, but not really good either.
14. I get motion sickness in cars and boats:
- ☐ a. hardly ever.  
☐ b. a lot.  
☐ c. sometimes.
15. I generally:
- ☐ a. use time to organize work and personal activities.  
☐ b. have difficulty in pacing personal activities to time limits.  
☐ c. usually am able to pace personal activities to time limits with ease.
16. I prefer to learn:
- ☐ a. details and specific facts.  
☐ b. from a general overview of things, and to look at the whole picture.  
☐ c. both ways about equally.
17. I learn best from teachers who:
- ☐ a. are good at explaining things with words.  
☐ b. are good at explaining things with demonstration, movement, and/or action.  
☐ c. do both.
18. I am good at:
- ☐ a. explaining things mainly with words.  
☐ b. explaining things with hand movements and action.  
☐ c. doing both equally well.
19. I prefer to solve problems with:
- ☐ a. logic.  
☐ b. my gut feelings.  
☐ c. both logic and gut feelings.
20. I prefer:
- ☐ a. simple problems and solving one thing at a time.  
☐ b. more complicated problems, more than one thing.  
☐ c. both kinds of problems.
21. Daydreaming is:
- ☐ a. a waste of time.  
☐ b. a usable tool for planning my future.



- ☐ c. amusing and relaxing.
22. I prefer classes in which I am expected:
- ☐ a. to learn things I can use in the future.
  - ☐ b. to learn things I can use right away.
  - ☐ c. I like both kinds of classes equally.
23. I am:
- ☐ a. not very conscious of body language. I prefer to listen to what people say.
  - ☐ b. good at interpreting body language.
  - ☐ c. good at understanding what people say and also in interpreting body language.
24. In school, I preferred:
- ☐ a. algebra.
  - ☐ b. geometry.
  - ☐ c. I had no real preference of one over the other.
25. In preparing myself for a new or difficult task, such as assembling a bicycle, I would most likely:
- ☐ a. lay out all the parts, count them, gather the necessary tools, and follow the directions.
  - ☐ b. glance at the diagram and begin with whatever tools were there, sensing how the parts
  - ☐ c. fit.  
recall past experiences in similar situations.
26. In communicating with others, I am more comfortable being the:
- ☐ a. talker.
  - ☐ b. listener.
  - ☐ c. I m usually equally comfortable with both.
27. I can tell fairly accurately how much time has passed without looking at a clock.
- ☐ a. Yes.
  - ☐ b. No.
  - ☐ c. Sometimes.
28. I like my classes or work to be:
- ☐ a. planned so that I know exactly what to do.
  - ☐ b. open with opportunities for change as I go along.
  - ☐ c. both planned and open to change.
29. I prefer:
- ☐ a. multiple-choice tests.
  - ☐ b. essay tests.
  - ☐ c. I like both kinds of tests equally.
30. In reading, I prefer:
- ☐ a. taking ideas apart and thinking about them separately.
  - ☐ b. putting a lot of ideas together before applying them to my life.
  - ☐ c. both equally.
31. When I read, I prefer to look for:
- ☐ a. specific details and facts.
  - ☐ b. main ideas.
  - ☐ c. both about equally.
32. I enjoy:
- ☐ a. talking and writing.
  - ☐ b. drawing and handling things.
  - ☐ c. doing both equally.
33. It is more exciting to:
- ☐ a. improve something.

- ☐ b. invent something.
  - ☐ c. both are exciting to me.
34. I am skilled in:
- ☐ a. putting ideas in a logical order.
  - ☐ b. showing relationships among ideas.
  - ☐ c. both equally.
35. I am good at:
- ☐ a. recalling verbal material (names, dates).
  - ☐ b. recalling visual material (diagrams, maps).
  - ☐ c. equally good at both.
36. I remember faces easily.
- ☐ a. No.
  - ☐ b. Yes.
  - ☐ c. Sometimes.
37. When reading or studying, I:
- ☐ a. prefer total quiet.
  - ☐ b. prefer music.
  - ☐ c. I listen to background music only when reading for enjoyment, not while studying.
38. I like to learn a movement in sports or a dance step better by:
- ☐ a. hearing a verbal explanation and repeating the action or step mentally.
  - ☐ b. watching and then trying to do it.
  - ☐ c. watching and then imitating and talking about it.
39. Sit in a relaxed position and clasp your hands comfortably in your lap. Which thumb is on top?
- ☐ a. Left.
  - ☐ b. Right.
  - ☐ c. They are parallel.



## BRAIN DOMINANCE INVENTORY SCORING

Number of A s \_\_\_\_\_

Number of B s \_\_\_\_\_

Number of C s \_\_\_\_\_

Your A s, B s, and C s must total 39, or your score is incorrect.

1. Compute your B score minus your A score. It can be a minus or a plus answer.

\_\_\_\_\_.

2. If your C score is 17 or higher, divide your B minus A score by three. Round your score to the nearest number. The answer will be your score. It can be a minus or plus number.

\_\_\_\_\_.

OR

If your C score is from 10 to 16, divide your B minus A score by two. Round your score to the nearest number. The answer will be your score. It can be a minus or plus number.

\_\_\_\_\_.

OR

If your C score is less than 10, do not divide at all. Your B minus A score is your answer.

\_\_\_\_\_.

### 3. NOW PLOT YOUR SCORE BELOW

-11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +10 +11

A score of 0 = Whole-brain dominance (bi-lateral)

A score of - 1 to - 3 = Slight preference toward the left

A score of - 4 to - 6 = Moderate preference for the left

A score of - 7 to - 9 = Left-brain dominant

A score of -10 to -11 = Left-brain dominant (very strong)

A score of + 1 to + 3 = Slight preference toward the right

A score of + 4 to + 6 = Moderate preference for the right

A score of + 7 to + 9 = Right-brain dominant

A score of +10 to +11 = Right-brain dominant (very strong)

*Note.* The original Brain-Dominance Inventory originally groups participants into 9 groups as 1) whole-brain dominance (bi-lateral); 2) slight preference towards the left; 3) moderate preference for the left; 4) left-brain dominant; 5) left-brain dominant (very strong); 6) slight preference towards the right; 7) moderate preference for the right; 8) right-brain dominant; 9) right-brain dominant (very strong). In order to simplify the analysis of data, the author has further suppressed the classification by including groups 2) – 5) into an overall left-brain dominant group, including groups 6) –9) into an overall right-brain dominant group, and remained group 1) as the whole-brain dominant group.

## Appendix I. The Edinburgh Handedness Inventory (Oldfield, 1971)

Participant No.: \_\_\_\_\_

### Handedness Questionnaire (Edinburgh Inventory)

Read each of the questions below. Decide which hand you use for each activity and then select the answer that describes you the best by making a cross in the corresponding column. If you aren't sure, try acting it out to see which hand you are using.

Please make sure that all questions are answered.

|   | left | either | right |
|---|------|--------|-------|
| 1. With which hand do you normally write?                                     |      |        |       |
| 2. With which hand do you draw?   |      |        |       |
| 3. Which hand would you use to throw a ball to hit a target?                  |      |        |       |
| 4. With which hand do you use your toothbrush?                                |      |        |       |
| 5. Which hand holds a knife when you are cutting things?<br>(not with a fork) |      |        |       |
| 6. Which hand holds the thread when you are threading a<br>needle?            |      |        |       |
| 7. When you strike a match, which hand holds the match?                       |      |        |       |
| 8. When you open a box, which hand holds the lid?                             |      |        |       |
| 9. Which hand holds the spoon when you are eating a soup?                     |      |        |       |
| 10. With which hand do you use scissors?                                      |      |        |       |
| 11. Which hand is at the upper part of the broom?                             |      |        |       |
| 12. Which hand holds the hammer when you are driving a<br>nail?               |      |        |       |



## Appendix J. The selection of stimulus words used in the lexical decision task

During the selection of stimulus words of the lexical decision task, some linguistic characteristics were first reviewed in order to eliminate possible confounding effects.

First was the word frequency/familiarity<sup>\*\*</sup>. In the case of visual word identification, most linguistic theories assume parallel encoding of letters within the orthographic lexicon. That is, all letters in a written word are processed simultaneously (e.g. the Dual Route Model by Coltheart et al., 1993; the Logogen Model by Morton, 1979; the PDP Models by Seidenberg & McClelland, 1989). Although the experimental findings about this issue are complex, it was found that high frequency medium length words (e.g. frequency > 25 per million) suggested no word length effect (i.e. longer words takes longer time to identify) and parallel process (Weekes, 1997). Accordingly, in order to determine the impact of the VI cognitive style on lexical decisions after controlling for any possible word length effect, only highly frequent and highly familiar words (familiarity rating (range from 100-700) > 500) with 4-6 letters were used as stimuli in the task. In addition, there are a few more confounding factors on lexical decision which need to be taken into consideration.

Imageability is one of the wide accepted influential factors for word recognition. The imageability of a word is the degree to which a word can be perceived as a mental picture (a scale range from 100 to 700 was used by Paivio, 1986). For instance, *hawk* and *cry* are two highly imageable words as they are easily imagined to be an image of object or scene. Whereas, *mercy* and *envy* are low imageable words that people find hard to associate with sensory properties or episodes (e.g. size, shape, feeling, etc.). Many studies have supported the superiority of the highly imageable words to those abstract words in lexical decision tasks (e.g. Bleasdale, 1987; De Groot, 1989; Rubenstein, Garfield, & Millikan, 1970; Schwanenflugel, Harnishfeger, & Stowe, 1988). There is

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<sup>\*\*</sup> The present study introduced familiarity scores as another index because it was thought to be a more robust estimate of how well known a word is (Gernsbacher, 1984).

neuropsychological evidence of the dissociation between the concrete and abstract word. (Note that imageability and concreteness are used interchangeable here.) Patients with certain lesions in the brain are selectively impaired for abstract words processing yet their processing with concrete words remains intact (e.g. Franklin, 1989; Franklin, Howard, & Patterson, 1995). Whilst a few reverse cases with impairment of concrete words but not abstract words were also found (e.g. Breedin, Saffran, & Coslett, 1994; Warrington & Shallice, 1984). The Dual Coding Theory explains such an advantage in that concrete words are activating both verbal and image representing systems while abstract words are activating the verbal representing system only (Paivio, 1971a). Therefore, this study specially chose low imageable words as target stimuli (average imageability score  $328.36 \pm 74.66$ ) in order to ensure the verbal nature of the task (i.e. only the verbal representations are activated during the lexical decisions).

In addition, there is an ongoing debate about the effect of the Age of Acquisition (AoA), which refers to the age at which one acquired a word, on the visual words recognition tasks such as lexical decision. It is logical that a word learned earlier in life will be better recognised and visually processed than a word learned later in life (e.g. Menenti & Burani, 2007; Stadthagen-Gonzalez, Bowers, & Damien, 2004). Whereas some findings suggest that AoA has little effect (Lewis, 1999; Zevin & Seidenberg, 2002), there is other evidence that AoA and frequency are influential factors (Ellis & Morrison, 1998; Gerhand & Barry, 1998). There are also studies, which imply that AoA is the only factor affecting performance on word recognition tasks (Brown & Watson, 1987; Vitkovitch & Tyrrell, 1995). Thus, AoA of the stimulus words needed to be controlled throughout the conditions.

Neighbourhood (N) size is the number of words that include one different letter from a particular word (Bowers, Davis, & Hanley, 2005). In other words, it is a measure of



the orthographic similarity between words (Coltheart et al., 1977). For example, the word *sell* is orthographically similar to many words such as *tell*, *well*, *bell*, *yell* and *sill* by simply replacing one letter; hence, it has a large neighbourhood size. In contrast, the word *deny* is orthographically similar to few words and only has the neighbours *defy* and *dent* ( $N = 2$ ). In lexical decision tasks, Andrews (1989) found a facilitatory effect of  $N$  size that words from large neighbourhoods elicit quicker responses than words from small neighbourhood size. The similar finding has been observed in a number of studies (e.g. Laxon et al., 1992; Scheerer, 1987). It propounds that a lexical entry would activate not only the target but also its neighbours, and this local neighbourhood activation somehow speeds up target access. However, competition was also found between orthographically similar words (neighbours). The inhibitory effect of  $N$  size in word recognition is reflected by the fact that words with orthographic neighbours will take longer to recognise compared to those with none. The precise mechanism of the  $N$  effect is still under debate. However, researchers did report that as long as a word has at least one orthographic neighbour, the effect between words with few or many neighbours is not as considerable (Bowers, Davis, & Hanley, 2005; Perea & Pollatsek, 1998). Thus, to minimise the possible  $N$  size effect during the lexical decision task, only words with  $N \text{ size} \geq 1$  were selected as stimuli.

All stimulus words (4 to 6 letter nouns) in the lexical decision task were originally derived from the MRC psycholinguistic database (Clarke, 1997) and then placed into a program, Neighbourhood Watch (Davis, 2005) to gain scores of the linguistic characteristics (e.g. frequency, familiarity, imageability, AoA,  $N$  size, etc.). Finally, stimulus words of the lexical decision task were chosen according to the above criteria (see Table 1 on the next page).

Table 1

*Stimulus words used in the lexical decision task in Chapter 6*

| Image Prime |          | Word Prime |          | Blank Prime |          |
|-------------|----------|------------|----------|-------------|----------|
| Word        | Non-word | Word       | Non-word | Word        | Non-word |
| ever        | beaz     | law        | wid      | mood        | sarn     |
| lack        | cend     | safe       | cate     | ease        | cege     |
| duty        | flah     | busy       | clet     | unit        | bame     |
| rate        | gand     | weak       | hant     | fool        | pand     |
| seek        | leck     | pick       | iren     | find        | fude     |
| rear        | porb     | glad       | somy     | deal        | sape     |
| grow        | sket     | hate       | thet     | pain        | prib     |
| blow        | sove     | west       | tobe     | task        | crun     |
| loss        | sush     | minor      | betch    | year        | bram     |
| theme       | blent    | being      | crand    | aware       | hotal    |
| worth       | crish    | order      | drial    | guilt       | spont    |
| skill       | horch    | sense      | lorge    | value       | carge    |
| broad       | skown    | peace      | shart    | month       | merch    |
| might       | steck    | style      | sorch    | guess       | prain    |
| whole       | whurf    | close      | thurn    | blame       | sheat    |
| choose      | bredge   | simple     | brants   | title       | grite    |
| belief      | clitch   | severe     | lasson   | proper      | stetch   |
| advice      | hupped   | normal     | pretch   | excuse      | granks   |
| search      | snutch   | weight     | spants   | safety      | clotch   |
| report      | sworve   | wonder     | tranks   | design      | stebble  |
| aim         | sab      | rare       | blug     | send        | sute     |
| able        | bobe     | fair       | cide     | wise        | wilk     |
| pure        | cife     | main       | colm     | pull        | lurd     |
| sell        | fote     | load       | hine     | calm        | frip     |
| firm        | gope     | wild       | shub     | harm        | bolg     |
| part        | pege     | gain       | stul     | term        | gend     |
| fill        | seeb     | sold       | thun     | luck        | cuge     |
| area        | sneg     | allow      | anemy    | type        | fune     |
| risk        | spuk     | loose      | borth    | other       | plown    |
| hold        | tord     | quick      | cruss    | worse       | ladio    |
| shown       | cland    | trust      | frosh    | cause       | swonk    |
| tough       | grink    | place      | scele    | alive       | splet    |
| moral       | prish    | blind      | slort    | tight       | frund    |
| fresh       | spead    | teach      | thard    | rough       | trabe    |
| broke       | whick    | become     | branks   | spite       | clain    |
| faint       | yorth    | recent     | crants   | slight      | shrain   |
| reason      | breeth   | effect     | loaked   | appear      | dattle   |
| repeat      | grewth   | matter     | pruise   | supply      | clants   |
| appeal      | slanch   | motion     | squate   | strain      | fretch   |
| threat      | sprine   | bitter     | whetch   | object      | threwn   |



Appendix K. The stimulus word pairs used in the relatedness judgement task

| Image Prime        |                      | Word Prime         |                      | Blank Prime        |                      |
|--------------------|----------------------|--------------------|----------------------|--------------------|----------------------|
| Related word pairs | Unrelated word pairs | Related word pairs | Unrelated word pairs | Related word pairs | Unrelated word pairs |
| choke              | suffocate            | scatter            | stay                 | pant               | snub                 |
| skill              | talent               | appear             | gasp                 | cope               | share                |
| moment             | minute               | trunk              | mercy                | appear             | guilt                |
| ignore             | snub                 | advise             | praise               | custom             | stir                 |
| rice               | grain                | bite               | fasten               | cult               | duty                 |
| rob                | burgle               | fate               | paper                | armour             | source               |
| hover              | fly                  | cater              | emerge               | theme              | ignore               |
| extreme            | limit                | strangle           | blame                | core               | stun                 |
| crumble            | decay                | judge              | skill                | berry              | crisis               |
| arise              | emerge               | prestige           | notion               | accuse             | wait                 |
| bake               | cook                 | opinion            | origin               | mercy              | utter                |
| duty               | chore                | soak               | flatter              | divide             | idea                 |
| thief              | crook                | rice               | chore                | fasten             | strangle             |
| art                | craft                | forbid             | snort                | sprinkle           | trunk                |
| circuit            | loop                 | emergency          | berry                | justice            | stir                 |
| soul               | spirit               | manage             | rob                  | annoy              | gripe                |
| greet              | welcome              | suffocate          | sob                  | drug               | lose                 |
| clench             | squeeze              | grain              | idea                 | welfare            | pint                 |
| guilt              | shame                | choke              | pull                 | coast              | poetry               |
| attach             | link                 | land               | shame                | virtue             | weep                 |
| flatter            | praise               | look               | mix                  | cloth              | soak                 |
| card               | paper                | attach             | wait                 | dangle             |                      |
| cling              | grip                 | grip               | lose                 | arrive             |                      |
| youth              | child                | attitude           | religion             | prestige           |                      |
| evidence           | proof                | gropo              | arise                | empire             |                      |
| ambition           | desire               | drench             | enter                | origin             |                      |
| preach             | talk                 | fabric             | armour               | luck               |                      |
| sniff              | snort                | limit              | event                | shine              |                      |
| forbid             | ban                  | cling              | pant                 | attract            |                      |
| cater              | provide              | speak              | accuse               | warn               |                      |

| Practice Block     |                      |
|--------------------|----------------------|
| Related word pairs | Unrelated word pairs |
| kipper             | alley                |
| alley              | herring              |
| brush              | lane                 |
| arrow              | broom                |
| crow               | dart                 |
| jump               | raven                |
|                    | bounce               |